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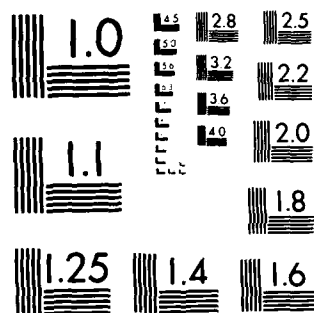
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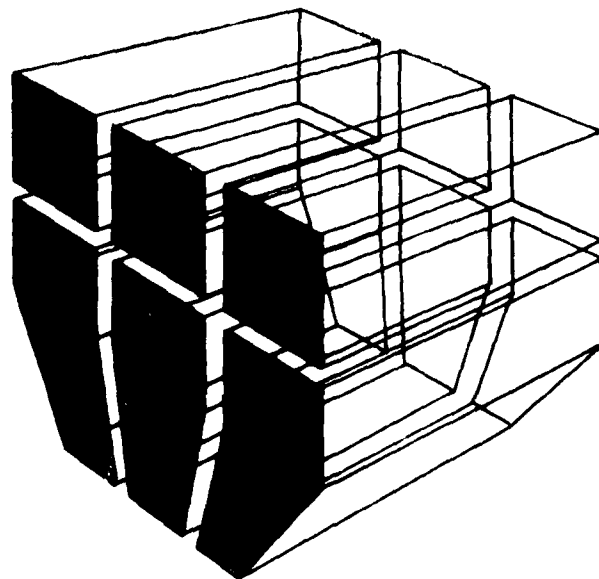
Environmental Early Warning Systems (EEWS): Equation Writer's Manual

by
Robert C. Lozar

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A conceptual description is given for development of the environmental impact demand equations that generate the results displayed on the Environmental Early Warning Systems (EEWS). EEWS was developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) for the U.S. Army Forces Command (FORSCOM). It is an interactive computer system designed to give FORSCOM planners and decision-makers a quick way to find potential environment-related problems associated with proposed changes in troop strength, mission, facilities, natural resource management, and land use. The system is intended to help Army managers during the earliest stages of planning and is not a substitute for current planning methods or Impact Statements.

To support the system's predictive capabilities, potential impacts and demands must be estimated. This report describes how these estimates can be made and how to format them for EEWS compatibility. Included are the steps in carrying out the background research on an area of interest, the way to translate this research into EEWS form, and how to format the data so that, when it is given to a data-loading expert, a smooth transition of responsibility results, with the work entirely documented. This information will facilitate an understanding of the equation development methodology.



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management, and land use. The system is intended to help Army managers during the earliest stages of planning and is not a substitute for current planning methods, Environmental Assessments, and Impact Statements.

To support the system's predictive capabilities, potential impacts and demands must be estimated. This report describes how these estimates can be made and how to format them for EEWS compatibility. Included are the steps in carrying out the background research on an area of interest, the way to translate this research into EEWS form, and how to format the data so that, when it is given to a data loading expert, a smooth transition of responsibility results, with the work entirely documented. This information will facilitate an understanding of the equation development methodology.

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FOREWORD

This work was conducted for the Assistant Chief of Engineers, Office of the Chief of Engineers (OCE), under Project 4A762720A896, "Environmental Quality Technology"; Task C, "Command Environmental Planning Strategy"; Work Unit 005, "Environmental Early Warning System." The applicable QCR is 3.01.002. The OCE Technical Monitor was T. Triceski, DAEN-ZCE. Support for field implementation of the system was provided through F. Klapp, AFEN-MSE, of the U.S. Army Forces Command (FORSCOM).

This investigation was performed by the Environmental Division (EN) of the U.S. Army Construction Engineering Research Laboratory (USA-CERL). Dr. Harold Balbach of USA-CERL was instrumental in the early development and continued support of the project. The EEWS software was originally developed through Analysis and Technology, Inc., New London, CT, with Richard Gauthier in charge of the programming.

Mr. Robert Riggins is Acting Chief, EN. COL Paul J. Theuer is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director.

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THE ENVIRONMENTAL EARLY WARNING SYSTEMS (EEWS): EQUATION WRITER'S MANUAL

1 INTRODUCTION

1.1 Background

Along with the Bureau of Land Management and the U.S. Forest Service, the Army is one of the nation's largest managers of public lands. Part of the Army's national defense mission is to keep these lands in good condition so they can be used for the training, development, and testing that will insure the armed forces are ready to meet any outside threat to the nation's security. Because these training lands--more than 12 million acres of mostly undeveloped forest, range, and desert--are an irreplaceable resource, the Army must preserve the quality of their natural environment.

The National Environmental Policy Act (NEPA) and Army Regulation (AR) 200-2 mandate that the Army consider environmental quality at the earliest conceptual stages of planning to expand or change training, management, support, or strength programs on its installations.¹ Until recently, the Army had no way to measure the impact of such changes on an installation environment until after much of the planning was complete and enough data were collected to allow an Environmental Assessment (EA) or an Environmental Impact Statement (EIS) to be written.

If an EA or EIS uncovers an environmental impact problem, the problem usually can be resolved by adjusting the Army's proposed program. But, in a very few cases, a major conflict results. Serious environmental problems that surface late in the Army's planning process during peacetime force expensive program changes that could jeopardize the Army's ability to fulfill its national defense mission.

Thus, the Assistant Chief of Engineers for the Environment asked the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to develop a method the Army could use to flag potentially serious environmental problems very early in the planning process. As a result, USA-CERL developed the Environmental Early Warning Systems (EEWS). The conceptual design² and user instructions³ for this system have been documented.

1.2 Objective

The objective of this work is to develop a method to enable headquarters at U.S. Army Major Command (MACOMS) and related organizations to identify potentially serious environment-related problems associated with changes in troop strength, mission,

¹The National Environmental Policy Act of 1969, Public (PL) 91 190, 83 Stat 852; Army Regulation (AR) 200-2, *Environmental Effects of Army Actions* (Headquarters, Department of the Army, 1 September 1981).

²R. Lozar and H. Balbach, *The Environmental Early Warning System (EEWS): Concept Description*, Technical Report N-144/ADA127356 (USA-CERL, January 1983).

³R. Belles, R. Lozar, R. Gauthier and M. Larson, *The Environmental Early Warning Systems (EEWS): User's Manual*, Technical Report N-86/06 (USA-CERL, January 1986).

facilities, natural resource management, and land use.* The purpose of this report is to detail the method by which impacts and demands are characterized in order to generate the sets of equations that form the backbone of EEWS.

1.3 Approach

The procedures and formats outlined here produce several results, the most important of which is a set of equations. The equations and supporting information comprising a set of equations in a given area of concern within EEWS (called a "Topic Area") are generated by a professional in that field (the researcher). This report describes the steps necessary to collect the data and the methods for integrating this information into a format understandable to a data loader. The instructions are based on observation of researchers doing the original work and on their suggestions for clarifying the steps involved. The entire process results in specific documents that characterize the impacts and demands so clearly that anyone may later pick up the researcher's work and understand the reasoning. Researcher documentation following these instructions should be clear enough to stand alone in published form (as in the *Topic Area Full Documentation Manual* referenced below).

In addition to the step-by-step instructions, examples from previously developed Topic Areas and equations are presented. The concepts used in developing these examples can be applied to any other Topic Area to be established within EEWS. This capability demonstrates EEWS' versatility in accepting new areas of evaluation when specific new concerns emerge as critical input to the Army planning process.

This report is organized to give the researcher an overview of the steps necessary to develop EEWS equations (Chapter 2). Chapter 3 describes how to put these data into a format that the EEWS equation loader will be able to understand. System limits as they relate to an equation writer are described in Chapter 4. Chapter 5 describes how EEWS allows the researcher to summarize impacts, and Chapter 6 explains the format into which a researcher must put data so the loader can actually put it into the system. Chapter 7 sets the standards by which the researcher must document the research in his** Topic Areas.

This report is one of a series supporting EEWS. The complete set of EEWS documents will include:

<i>Concept Description</i>	Published January 1983. Contains the initial description of the logic, reasoning, and technical requirements necessary for establishing the EEWS.
<i>User's Manual</i>	Published June 1986. Contains information necessary for the day-to-day use of EEWS by Army planners. It is intended as a basic tutorial for persons unfamiliar with computers and/or EEWS.

*The current system's data base supports the U.S. Army Forces Command (FORSCOM) and the U.S. Army Training and Doctrine Command (TRADOC).

**The male pronoun is used for convenience throughout this report to mean both genders.

<i>Equation Writer's Manual</i>	Current publication. Contains the procedures for collection and synthesis of data for use by EEWS. It explains the generation, storage, and documentation of data and equations and is intended for advanced specialists developing the reasoning that supports EEWS output. Specialists should be familiar with the daily operation of EEWS, but not necessarily the technical aspects of the system.
<i>Data Input Manual</i>	Will deal with the entry and modification of data contained in EEWS. Intended only for advanced users familiar with EEWS and comfortable with the use of a computer.
<i>Topic Area Brief Documentation</i>	Will give a one-page summary of the intent of each of the initial Topic Areas, how each works, the data sources used, and the equations supporting the summary reports within EEWS. Also included will be the complete list of the inputs and the output names (the names of the equations that generate the outputs). Aimed at the general user as a companion guide to the <i>User's Manual</i> .
<i>Topic Area Full Documentation</i>	Will give comprehensive background into research required by each Topic Area to support those concerns developed into EEWS outputs. Summarized methodology, data sources, assumptions, and limitations will be provided for review by specialists highly familiar with EEWS operation.
<i>EEWS Examples</i>	Will give advanced examples illustrating the problem-solving capabilities of EEWS. Intended for persons familiar with the daily operation of EEWS.
<i>System Maintainer's Manual</i>	Will explain all technical information necessary for the operation of EEWS, including the procedures necessary to keep EEWS working properly. Intended only for computer programmers familiar with EEWS and the operating system in which EEWS resides.

1.4 Scope

Before an individual attempts to develop EEWS equations, it is expected that he will have become acquainted with the other documents supporting the system. This report is not intended to stand alone, though it is the basic reference for developing the demand and impact algorithms which are the driving force in EEWS.

1.5 Mode of Technology Transfer

EEWS is targeted for users at MACOM-level planning offices. EEWS is being transferred to these users through hands-on experience and tutoring. When development and testing are complete, the system will be transferred to all MACOM and related organizations that can benefit from predicting environmental impacts at an early stage in the planning process.

2 STEP-BY-STEP PROCEDURE FOR DEVELOPING EEWS EQUATIONS AND DOCUMENTATION

2.1 System Overview

EEWS has exceptionally versatile capabilities in allowing many types of potential impacts to be modeled. The current system has more than 12 areas of concern (Topic Areas*) already implemented. These Topic Areas vary in subject matter from purely environmental concerns (Rare and Endangered Species) to those unique to the Army (Manuever Areas) to demands characteristic of any planning situation (School Student Places or Medical Facilities). Upon request, other areas of concern can be characterized and developed by a professional in a particular field who need have no previous understanding of EEWS or programming experience. However, previous exposure to the usage of computers is assumed.

Translating professional knowledge into a form that EEWS can use is a relatively easy task. However, the researcher must understand the process, rules, and required supporting development documentation to do the translation.

Each output the user sees as part of an EEWS session is the result of an algebraic or logical evaluation done within EEWS and based on the equations which characterize environmental effects. By considering the requests a user might make during an EEWS session, the specialist for a particular Topic Area decides which ones would potentially cause delays or additional costs in a mission change or a realignment. The changes the user may request are the clues to the types of effects likely to result. Thus, the equation researcher's duty is to integrate these clues into equation form ready for EEWS input. Since EEWS can make no predictions without a well written, descriptive equation, these equations can be considered the cornerstone of the EEWS concept; in fact, they describe all the work that must be done to result in a useful user output.

Although the method of writing an EEWS equation is described in the next chapter, this step is only one in a series involved with generating equations. The procedure may vary considerably due to the individual involved in the research, the overlap between one Topic or Subtopic Area and another, or the time needed to acquire the supporting data. However, each Topic Area requires certain standard steps. It should be noted that the procedure described in this chapter does not require that the steps be carried out consecutively; in fact, this is rarely the case. More often, several steps are attempted concurrently because they are all interrelated.

The procedure can be divided into two parts. The first part involves development and testing of the equation; this portion of the work is primarily the researcher's responsibility as outlined in Steps 1 through 20 of Figure 2-1. After Step 20, the work largely consists of having the equations tested, polished if necessary, and loaded onto the system; the data to support the equations also are collected and loaded. During this time, a large portion of the work shifts to another specialist--the EEWS data loader. However, the researcher still is responsible for ensuring that the correct data are obtained, equations are in the system as intended, and test runs of the EEWS program give the results expected.

*"Topic Areas" are used interchangeably with "topics" in other EEWS reports.

Subtopic Area Researched: _____

1. Part of Topic Area: _____
2. Assigned researcher: _____
3. Divide Topic Area into workable Subtopics.
4. Formulate flowcharts to separate and show interrelationships between Subtopic Areas and their desired outputs.
5. Check whether any of the data or equation results are already available in completed Topic Areas.
6. Survey Topic Area background materials (review relevant portions of researcher's professional background).
7. Determine which Army actions are likely to affect this Subtopic Area.
8. Survey official Army demand criteria (Army background).
9. Refine flowcharts for each specific Subtopic Area and estimate difficulty of accomplishing each step (Figure 2-2).
10. Write preliminary equations (Figure 2-2).
11.
 - (a) Compile a list of potential data sources.
 - (b) Check to see if data are available locally (USA-CERL).
 - (c) Check to see if data are already available in EEWS.
12. Examine potential data sources, search for new data sources, and identify sources for both TRADOC and FORSCOM.
13. Determine:
 - (a) The most installation-specific data available.
 - (b) The most accurate data available.
 - (c) Which data are readily available.
 - (d) Data which are widespread.
14. Formulate preliminary equations (Figure 2-3) in a non-EEWS format based on:
 - (a) Flowcharts
 - (b) Factors affecting Subtopic Area.
 - (c) Probable availability of data.
15. Put test equations into EEWS form (Figure 2-4).

Figure 2-1. EEWS equation generation—step-by-step procedure.

-
16. Test equations using data likely to be available.
 17. Check to make sure no other researcher has used desired abbreviations (Figure 2-5).
 18. Calculate expected resultant value manually.
 19. Determine which equations will be reflected in the SUM report and write them.
 20. (a) Check for the possibility of zero divide.
(b) Determine appropriate TYPICAL values.
 21. Load test equations into EEWS.
 22. Data loader receives test data.
 23. Load test data.
 24. Run data through equation in computer.
 25. Check to insure correctness of computer-derived value against value derived manually.
 26. Firm up equations and data sources or return to Step 4: Formulate flowcharts, or Step 14: Formulate preliminary equations.
 27. Load final equations into EEWS.
 28. Data loader receives full set of data (Figure 2-6).
 29. Load all data.
 30. Verify data.
 31. Verify equation results are correct by making test EEWS user sessions.
-

Figure 2-1. (Cont'd)

2.2 Individual Steps and Examples

2.2.1 Researcher Responsibilities

A researcher is first assigned an area of investigation (a Topic Area) based on that individual's expertise in a professional discipline and previous experience with EEWS. The procedural summary sheet (Figure 2-1) is then filled in for Step 1: Topic Area, and Step 2: Assigned Researcher. Normally, Topic Areas are so encompassing that the first step is to divide the different concerns into Subtopic Areas so that the researcher can concentrate on each one separately. Thus, the title of each summary sheet is the "Subtopic Area" (or "Topic Area" if that area is simple and straightforward). For example, the Topic Area "Utilities" has been divided into the Subtopics "Water Usage," "Water Supply," "Sewerage," "Heating," "Electricity," and other related areas. This division into working units is done in Step 3.

Sometimes Subtopic Areas are related (e.g., Water Supply and Water Usage). In these cases, Step 4 is used to define the relationships so that further work will be coordinated.

A researcher with expertise in a discipline knows immediately, in general, what data inputs will be required to support the questions he is investigating. At this earliest step, he should outline those requirements and investigate whether some of the data have been collected or whether other researchers looking into similar questions have located sources of the desired data or found that it is available under another name, another system, or not at all, and from whom it is or is not available. This information will help determine the parameters with which the researcher will have to deal. In addition and as part of Step 5, the researcher should see if researchers in other Topic Areas have generated outputs that would be useful inputs to his own areas of concern. Usually, the way to determine this is to explain the general idea to the individual responsible for coordinating development among all the areas to find out if he knows of other researchers who may have the desired data, equation outputs, or information exposure. In addition, the *EEWS Topic Area Documentation* (full and brief) will show explicitly what is available in other areas of concern.

Steps 6 through 8 usually are done concurrently. When a researcher outlines the general problem (Steps 4 and 5), he uses his professional background to analyze the research questions in terms of what must be considered in accomplishing the task at hand (i.e., what factors may have bearing on the outcome). Step 6 suggests that the researcher may wish to refer to a college textbook on the area of concern to learn what will be required for the Subtopic and how one consideration affects others. The researcher is likely to already have this knowledge as part of his professional expertise. Sometimes the Army's mission and activities can be very different than those of other organizations; for example, not many tracked vehicle training areas are found outside the military. Thus, the next question to consider is "how is the Army different and how will this affect the Subtopic Area?" Other Army activities are similar to comparable civilian activities that have environmental consequences (e.g., housing or utilities).

Whether or not the activity under consideration is unique to the Army, there is probably a regulation or set of criteria outlining appropriate measures for Army planning. Several publications deal with Army or Department of Defense (DOD) criteria. Examples of these sources are given in Appendix A. This list is not intended to be complete. It is the researcher's responsibility to obtain all sources that may apply to the work. At the end of Step 8, the researcher should have a good idea of what data are available, what Army standards might be applicable and, most importantly, how a change

in the level of personnel or equipment at an installation may affect an environmental concern. This last question is critical because it is the point of all EEWS research. Simply being able to characterize the current situation at an installation, though a big job, is not enough. EEWS is a predictive tool--not a data storage and retrieval system. If the researcher at this point does not have at least a conceptual idea of how a change may affect the environment, then this step has not yet been completed.

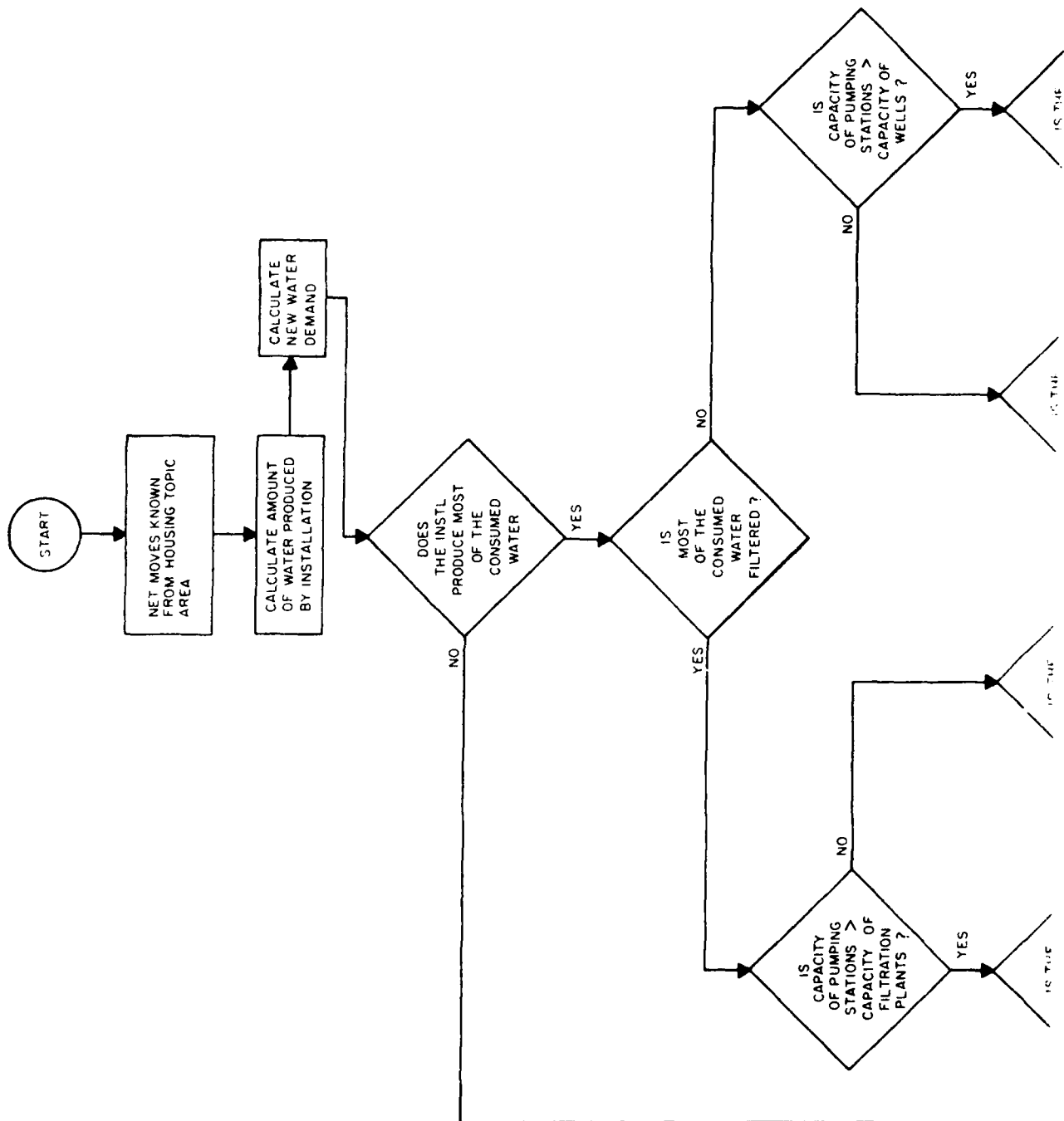
Once the researcher has some concept of what he wishes to accomplish, he must begin to document the work. At this point, a flowchart should be drawn. The best rule for developing a flowchart is to keep it simple. This rule is important because the logic behind a simple flowchart is immediately apparent, easy to justify, avoids hidden assumptions and pitfalls, and is easier to carry out than a complicated flowchart. A good flowchart allows the researcher to:

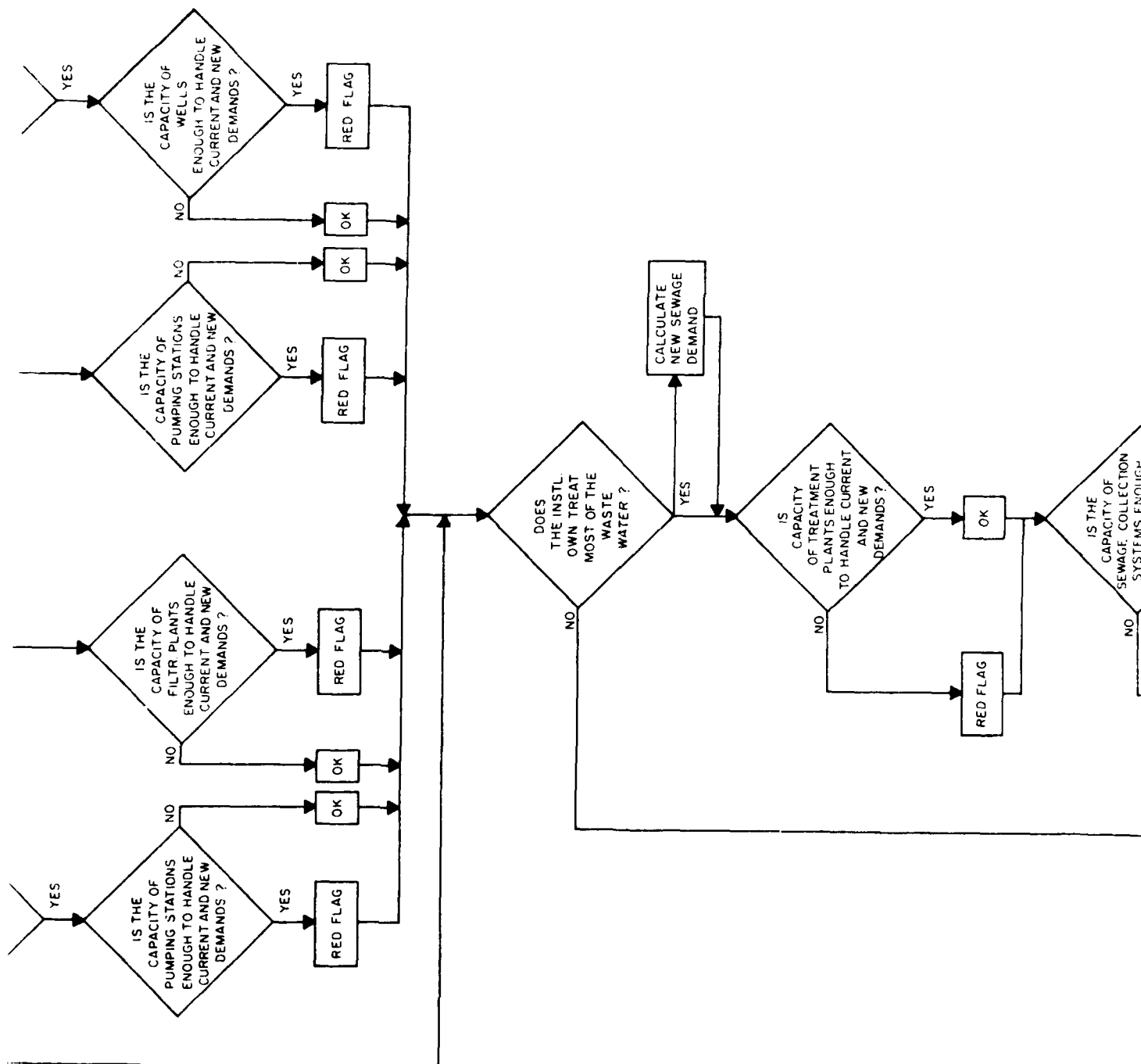
1. Define outputs that would be informative for the eventual EEWS user.
2. Gain a feel for whether the supporting data might be available.
3. Try to define how the intended inputs can be used as a series of connected steps to arrive at a desirable set of outputs.
4. See how Subtopic Areas relate to each other within the overall Topic Area and how Topic Areas not assigned to him relate to the questions at hand (as data sources from either the data base or from outputs of equation calculations in other areas). Figure 2-2 is the flowchart for the Subtopic Area Water in the Utilities Topic Area. It shows that the first consideration is that data are required from another Topic Area--Housing.

When a flowchart has been developed, it is wise for the researcher to estimate the probability of finding the data and the connections needed to gain the outputs required. Usually, the lower portion of the flowchart is where the most desirable outputs to the user reside. If the probability of completing an interim step is low, then gaining the final output (the cumulative probability of all interim steps) will be low. If this is the case, the researcher must change the interim steps to increase their probabilities and therefore the final cumulative probability or he must admit that the final outputs, as defined, are not reasonable goals. In this case, the flowchart must be changed or the researcher must conclude it is not possible to proceed as far as originally thought. This estimation procedure will prevent a researcher from putting a great deal of effort into generating outputs which are steps toward an unreasonable distant goal.

Each box or group of boxes in Figure 2-2 defines a preliminary equation for Step 10. For example, the last question, "Is the storage capacity enough to meet the limiting requirements" is a logical equation that makes a comparison. It (1) defines a desired output, (2) defines data types that will be required to support it, (3) shows how the steps before and after it are related, and (4) states that data outside this Topic Area are not required in this step. In addition, the flowchart suggests that this question will require several equations to be written and documented. This situation is not unusual, in that Topic Areas usually have several equations--10 to 40 would be normal. Some Topic Areas have more than 100 equations (e.g., Housing, which generates data used to support equations in Topic Areas pertaining strongly to the environment).

Now that the researcher has an outline of the work to be done, the first concern must be to learn if the input data are available. Step 5 should have produced some understanding of which data might be available. At Step 11, the researcher refines the





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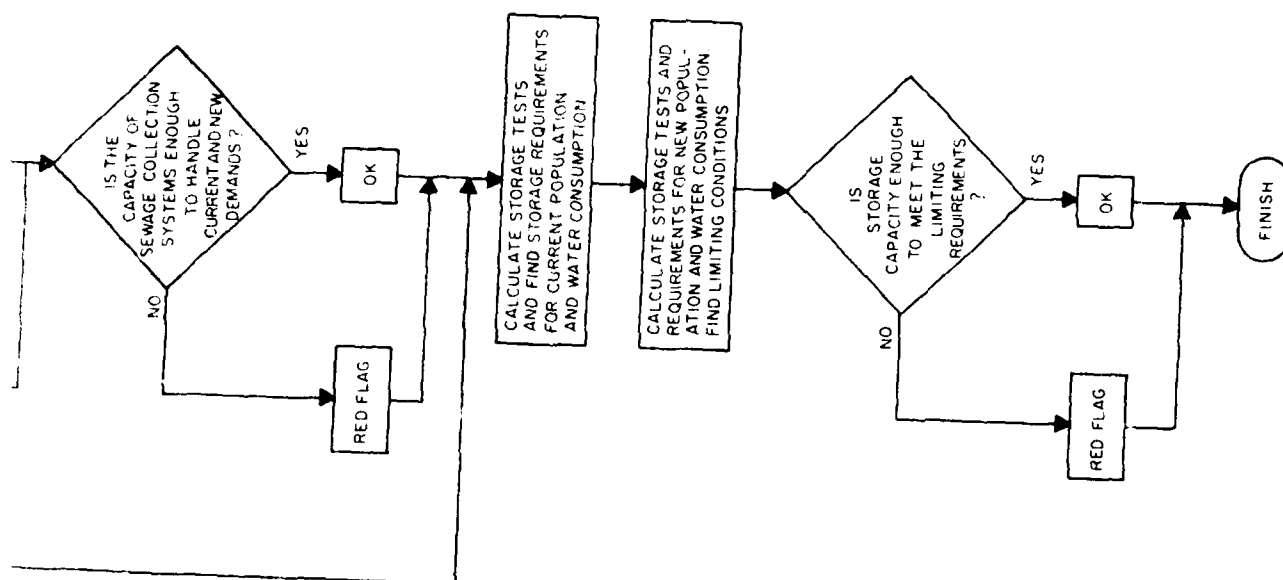


Figure 2-2. Water Subtopic Area flowchart.

specific data requirements, defines the probable source documents, and estimates how difficult they are to obtain. Since the flowcharts imply that one evaluation depends on another, it is critical to confirm the data's availability at the earliest stages of development. Though this work is really done in Step 14 when the preliminary equations are formulated, the importance of ensuring the availability of data will be emphasized again and again because ignoring this consideration until the latter stages has been the major pitfall in the equation-generating process. In other words, an equation without input data is of no use at all. Answering each point in Step 11 helps avoid this problem. (See the paragraph above discussing cumulative probability of completing the flowchart steps.)

Data have several properties that must be examined in Steps 12 and 13. Up to this point, the researcher may not have any data sources physically in hand. Thus, though individuals may have claimed, "The value of the desired surplus is in publication X," the researcher must now confirm this. Several possibilities must be eliminated to ensure the data are available. For example, information cannot be classified and it must be from a centralized source (the MACOMs, DOD, or a military or civilian agency). Surveying all the individual installations is time-consuming, expensive, slow, uncoordinated in quality, bothersome to the installation personnel, and cannot be updated without similar effort. Thus, a survey is not allowed for gathering data to support EEWS. Data must be recent and it must be possible to update if it changes over time. The agency that holds it must be willing to share it with the researcher. It must be accurate and must cover all or most of the major continental United States (CONUS) installations. To make EEWS installation-specific, the data must differ at different Army installations. Also, it must be the best available, which usually means it must be from the first coordinating agency above the installation level (most often the MACOMs). However, the different MACOMs may not use the same forms or may not have adopted the same definitions; or, one MACOM may have collected the data and not the other. If a researcher wishes to use MACOM-level information, he must insure that it will be available for all MACOMs under consideration (currently FORSCOM and TRADOC). Though DOD-level data are consistent between MACOMs, they usually are not as detailed as those available from DOD subdivisions (e.g., the MACOMs). With all of these considerations, it is clear that each source needs to be investigated thoroughly. When Step 13 is done, the researcher may have to spend more time back at Step 12 trying to find a new data source or reevaluating whether the data originally thought necessary really is. Again, simplicity may be the most reasonable way to handle a problem.

In addition, the researcher may find that potential sources are not useful in supporting his Topic Area. This information is important to document to save another researcher from wasting time following the same futile path. In addition, when equations are in place, data are loaded, and the sponsor sees the results and asks why the equation researcher did not use a well known data source, the researcher's documentation must provide the answer. Usually, the answer is, "Our researcher did investigate that and found that the data source had the capacity of X but not the surplus X available, which is what we really need to know." The answer, "His documentation does not indicate if he investigated that data source" is not acceptable.

In Step 14, the idea is to translate the flowchart developed as in Figure 2-2 into written equations (Figure 2-3). Each node in the flowchart usually will translate into an equation (or a series of equations that generates similar results). Equations in EEWS can be either algebraic expressions or logical evaluations. In this step, the equations need be no more than written algebraic or logical evaluations like those taught in high school mathematics courses. The variables and constants can be represented by several words or even sentences. At this step, the equations should be so clear that anyone can read

From Figure 2-2, how does the question in the flowchart, "Does the installation produce most of the consumed water?" appear in equation form?

=====

(Produced Water Greater?) =

IF	$\frac{\text{Existing Water Production}}{\text{Existing Amount of Purchased Water}}$	GREATER THAN 1.0
----	--------------------------------------------------------------------------------------	------------------

THEN the equation result will be a value of 1.0

ELSE the equation result will be a value of 0.0

Figure 2-3. Preliminary equation in non-EEWS format.

them and understand what the variables mean and what the equation will generate. In addition, anyone who looks at the flowchart should be able to see how each equation relates to all the others in arriving at an EEWS output. This step is later documented on the Equation Form under "Specific Equation."

The first payoff in all this work occurs in Step 15: Formulate Test Equations in EEWS Form (Figure 2-4). Though a lot of work may have been done up to this point, none of it has any value to the EEWS equation generation task if this next step is not completed. Experience has shown that if the responsibility for finishing a Topic Area is transferred to another person before this step is completed, the new researcher will begin all over rather than pick up where the previous researcher has ended. This means that endless surveys and evaluations of potential data sources are not useful if the process is not aimed at finding a small number of critical pieces of data. Massive amounts of spurious data are not desired or needed.

Translating the high-school level equations from Step 14 into EEWS form is a simple matter of knowing the EEWS system rules. Chapter 3 describes the procedure in detail. To summarize what occurs in this step:

1. The abbreviated names of the results and variables are defined.
2. Specific locations of the individual pieces of source datum are stated explicitly. If the data ever have to be recollected, not only the name of the data source, but also the page number, line, and column **MUST** be stated. If only the source is given, the next person to update the data will have to look through an entire document to find updated information--something the original researcher has already done.

Figure 2-4. Completed EEWS Equation Form for a coastal zone consideration.

3. The placement of data within EEWS is defined. If the information is an input to an equation that causes changes due to user requests, it belongs to the file called UNITYPE. If it is a value associated with all installations, it belongs in the equation as a constant. If it is a value that changes between installations, each value belongs within each installation's own data file (in an "INSTL" file) and is also a variable in the equation. If it is a result, it is called a DESCRIPTOR.

4. Much of the documentation associated with the development of a single equation (or a group of equations that produces similar results with different data) is placed on the EEWS Equation Form as shown in Figure 2-4. When an EEWS data loader puts the equation into the computer, he will also be inputting some of the documentation (descriptor, note for the equations' terms, variable names, sources, notes, assumptions, threshold, units of measure). These data must be provided on the form. The data loader has neither the time nor expertise to supply this information while the computer is waiting for input.

Steps 16 through 18 are intended to be checks on the proposed equation to ensure it will work correctly. Step 16: Test Equations Using Data Likely to Be Available, says "From your proposed data sources, can you really pull out a piece of data that your equation requests and put it in the equation?" This test is done by putting the values at the bottom of the Equation Form (Figure 2-4) on the line "Specific Values for Fort." If you cannot do this for all the data you have requested for at least one installation, it is unlikely that you have checked your data sources carefully enough. All data from all equations within a Topic Area should be real, consistent, and coordinated within the Topic Area. When the researcher later checks the computer calculations (in Step 25), the loaded Topic Area can be confirmed by inputting the data generated and documented in this step and by using the manual calculations in Step 18.

Step 17: Check to Make Sure No Other Researcher Has Used Your Proposed Abbreviations, avoids confusion in the user's interpretation of outputs in different Topic Areas and in the names of inputs in the INSTL data base. The easy way to check this is to scan through the Unified Matrix for the other Topic Areas (as in Figure 3-5 in Chapter 3).

In Step 18, the researcher does the calculations that his equation requires using the data values found in Step 16. This step is easy to do and can be documented immediately on the EEWS Equation Form on the "Sample Calculation" line. The purpose is to: (1) show that the equation works, (2) ensure that the result is reasonable and is what the researcher was expecting, and (3) confirm that the sign on the result (+ or -) is correct and coordinates with the meaning of the descriptor's abbreviation.

As a final step in refining the Topic Area, the researcher must determine which equations of those generated are critical. If their results indicate a problem is present, this fact should be reflected in the more generalized reports--SUM(mary) and BRIEF. This concept and how to determine it are described in detail in Chapter 5. To simplify here, the more generalized SUM(mary) report looks at any descriptors beginning with a plus sign. If a negative value results from the calculations supporting that plussed descriptor, as displayed in the RESULTS report (i.e., demands), then the SUM report will automatically show a problem for that "plussed" descriptor. The researcher decides which equations are to be "plussed" descriptors, since he is considered the most knowledgeable individual in his Topic Area. Therefore, designation of plussed descriptors is based on his best professional judgment. Army criteria or professional standards also may be sources for critical consideration.

Plussed equations are written in a way similar to other equations. However, the rule is that a negative resultant value of a "plussed" equation will make higher order reports indicate a problem (Chapter 5).

One constant pitfall for equations is: what happens to it when zero (or a similar difficult value) is used. In Step 20a, the researcher examines his equations according to section 3.3.5 and determines what alternatives are reasonable. In step 20b, the researcher decides what his equations should do if no data values are found. Without knowing how to react, the system will not run. Methods for defining default or TYPICAL values are described in Chapter 6, section 6.4.

At the end of Step 20, the researcher has reached the preliminary goal of having the initial Topic Area material ready for computer input. Assuming he has done a good job, the components in hand at this time are: (1) a conceptual outline of how the entire area relates to the individual equations (Steps 9 and 10), (2) an in-depth explanation of the reasoning behind each step (Steps 6, 7, 8, and 14), (3) an in-depth list of data sources examined, along with what each contains and why those proposed were adopted (Steps 11, 12, 13, and 16), (4) the equations that coordinate exactly with the flowcharts and explanation, (5) at least a beginning set of data (Steps 11b,c, 13c,d, 14c, and 16) ready to be loaded for testing (it is better to have the complete set of data ready to be loaded at this point--see Figure 2-5), and (6) data dealing with the Topic Area as a unit (Chapter 4).

These six components constitute the documentation for a Topic Area. All Topic Areas must have this documentation. At this point, the documentation should be almost complete, easy for anyone else to understand without questions, and almost ready for publication. Since the research probably will have exposed new and helpful concepts, data sources, or estimation procedures, the researcher should expect the results of this work to be published. The published material will come directly from the six components above.

2.2.2 Researcher/Data Loader Cooperative Responsibilities

At this point, the intense equation development by the researcher ends and he now works with the equation/data loader as part of a team in ensuring that data entered into the computer are those desired and that EEWS is acting as expected.

The next two sections of the procedure (Steps 21 through 26 and 27 through 31) are largely redundant. In Figure 2-1, they are divided into two parts only to imply that the researcher needs to check the work. Since it is an involved task to load the material, in practice, the two sections are done concurrently. This means that at Step 21, the researcher should be very sure of his work; it should have been reviewed by others so that it is acceptable to the project sponsors. This review is best done during the entire process so the researcher never puts much effort into generating an unacceptable result.

Loading equations (Steps 21 and 27) is the data loader's responsibility. The information loaded is that on the Equation Forms and other components of the supporting documentation (i.e., Topic Area characteristics and the data). The data loader theoretically should not need to ask the researcher any questions; in practice, this rarely happens. The data loader may discuss with the researcher the number of equations and the names of categories, how they will be numbered in EEWS, clarifications as to the correct lengths of the descriptors and category abbreviations, and the file types belonging to the variables. The data loader is responsible for coordinating a great deal of input coherently. Coordination with the researcher and a set of well documented

INSTALLATION DATA

Ft A P HILL, GA

WATER CONSUMPTION

DESCRIPTOR	EXISTING	RESULT	THRESHOLD
WATSERV	35,393	----	----
PURCWAT	000	YES	----
UNFILPRODWT	35,393	YES	----
CAPPUMPST	3,352	YES	----
CAPFILTRPL	000	YES	----
CAPWELLS	1,309	YES	----
SOILCOEF	0 60	----	----
EFFICCOEF	1 00	----	----
MAXPUMSTDEF	1 00	YES	1 00
CAPFILTRPLDEF	1 00	YES	1 00
CAPWELLSDEF	1 00	YES	1 00
TEMPPRODCEOF	---	YES	----
TEMPUNFLCOEF	----	YES	----
TEMPFILTCOEF	----	YES	----
PERWATCONSON	----	YES	----
PERWATCONSO	----	YES	----
EQWATCONSON	----	YES	----
NEWWATDEMOM	----	YES	----
CAPPUMSTUR1	----	YES	----
CAPPUMSTUR2	----	YES	----
MINPUMSTUR	----	YES	----
CAPFILTRPLSUR	----	YES	----
CAPWELLSUR	----	YES	----

Figure 2-5. Data ready to be loaded.

components make this task much easier. Items that seem obvious or too simple to document on the Equation Forms (e.g., the units of measure on a term or whether the different sections of a descriptor name are separated by a dash or underscore) may cause the data loader to stop the input work. The data loader must state these items explicitly and they are often input before the actual equation can be entered. Much of the information on the Equation Form will be input to EEWS; it is not spuriously requested data.

Steps 22 and 28 are the points in the process at which the loader physically receives the data from the researcher. This transfer should have been completed previously during documentation, so these steps are just a check to ensure that the researcher/loader work has been coordinated. Figure 3-5 in Chapter 3 and the formats in Chapter 6 show acceptable forms for the data.

Data cannot be loaded in Steps 23 and 29 unless the terms have been input, descriptors have been defined, and the equations have been documented completely. Thus, if the data are available, but the equations are not finished, no data can be input. The purpose of the entire research process is equation development, not data gathering, because the equations drive EEWS.

Once the equations and data are loaded, the correctness of the result must be tested and judged as meeting expectations (Steps 25 and 30/31). The data loader is not responsible for understanding the technical results of the research. Thus, verification of the equation's computer output is the researcher's responsibility. It is not reasonable to have expended all the previous effort and then not verify the computer output. At this stage, the most common problem with incorrect output is due to a lack of parentheses in an equation to make the order of its manipulations explicit. This deficiency usually can be corrected by modifying the equations in the computer. *More serious problems may require a reevaluation of the entire methodology (Step 26).*

Steps 27 through 31 have already been discussed as part of Steps 21 through 26.

This chapter has described the Topic Area development process in which a large set of equations is generated; Chapter 3 gives details on how to set up each individual equation.

3 WRITING EEWS EQUATIONS

3.1 Overview

Examples are provided to show: (1) from where in the computer the data to support equations are taken, (2) how to write EEWS equations to simply display information stored in data bases specific to different installations, (3) how to write a basic EEWS equation that responds to user-submitted changes, (4) how to use a result from a previous equation in another equation, (5) how to use logical and algebraic evaluations, (6) how to avoid displaying an interim calculation to a user, (7) how to display a word rather than a number as an output to a user, and (8) how to keep the calculations from stopping due to a division by zero.

3.2 Data

As discussed in Chapter 2, the researcher identifies information needed to support equations as part of the developmental work. The researcher then tells the data loader what form of input will be needed to support the equation. This information is communicated through the standard Equation Form (Figure 3-1a), a continuation page (Figure 3-1b), and a Notes Form (Figure 3-1c). In EEWS, data to support the equations come from three different types of storage files: UNITYPE, INSTL, and TYPICAL.

3.2.1 UNITYPE

The first type of file makes the connection between inputs by the user and those used in an equation. The user makes inputs by entering the kind of unit he wishes to move from one location to another. Units can be composed either of individuals or groups of equipment and individuals (Figure 3-2). As an example, consider unit number U91. "U91" is what a user inputs during an interactive EEWS session. The Army calls unit 91 a "17000H020" (the TO&E or SRC number--see Appendix B) which is an "Armored Division" of a particular type. When a user moves a U91, EEWS goes into its data banks and finds out what comprises that unit. According to Figure 3-2, it consists of a certain number of individuals of different grades and certain amounts of equipment of different types. For example, there are 3374 E4s (enlisted persons of grade 4) and 55 155-mm howitzers. When a researcher writes an equation that requires a UNITYPE input to make a calculation, he is defining one of three components that will have some effect in calculating the results of an equation:

1. A piece of equipment (e.g., howitzer)
2. A "group" of equipment (e.g., the group "tracked vehicles")
3. A type or grade of individual or group of grades (e.g., E4s).

These researcher-defined inputs or categories (e.g., components of the Army unit with the EEWS number U91) are stored as part of the list characterizing that Army unit within the data base that holds all Army unit information--the UNITYPE file. Equations will be pulling the requested values out of that Army unit's list in the UNITYPE file. The values will be equation inputs that the equation will use to determine its result. Support

(g)

[illegible]

Figure 3-1. (Cont'd)

(c)

<p style="text-align: center;"><u>NOTES FORM</u></p> <p style="text-align: center;">(VALID NOTE NUMBERS FOR TOPIC AREA _____ ARE ____ TO ____ INCLUSIVE)</p> <p>NOTE# _____</p> <p>TEXT:</p>

Figure 3-1. (Cont'd)

• 1

iv

T(1)W

1192

E1

Figure 3-2. Examples of Army units as stored in EEWS.

programs* have been developed to help the researcher pull from the TO&E tapes the inputs he has defined as needed for the equation. Complete hard-copy examples of TO&E listings also are available. Figure 3-3 is an example TO&E list for personnel and Figure 3-4 is an example list for equipment. Most UNITYPE EEWS inputs will be references to TO&E listed items or to congregations of TO&E listed items. It is the researcher's responsibility to tell the EEWS system maintainer what information is desired from the TO&E tapes. To tell the data loader or system maintainer which categories are required to support the equation, the researcher enters the information on the Equation Form under "Inputs" or on a Unified Matrix (Figure 3-5) for the Topic Area of concern. If a needed input is not available from the TO&E tape, that can also be accommodated as part of the UNITYPE file (see "Non-Unit Type Inputs" in Figure 3-1a); however, the researcher must acquire the data and determine how it is to be loaded into the file or tell other EEWS support personnel exactly how to acquire it. For example, in Figure 3-2, categories exist that do not seem to belong to a unit. At the very bottom of the list for unit type U91, there is "CZM" (Coastal Zone Management). Although a coastal zone management area does not belong to an Army unit, the researcher has said, "We will want inputs for our equation which deal with a CZM area." To provide for this capability, the researcher reserves a category, CZM, on the Equation Form (or the Unified Matrix) as part of the equation input. This category then becomes one of the places from which EEWS equations can take information.

3.2.2 INSTL

Another location from which data are taken is the group of files characterizing each installation. That is, each installation has its own file. Figure 3-5 is an example of the data base layout for one entire Topic Area (among several Topic Areas)--Medical. It shows all storage locations for all installation-specific input that would be necessary to run the Medical equations. Each installation has a Medical data base which is organized exactly in this way, but contains values at the darkened locations in Figure 3-5 which are specific to that installation. Each installation data file belongs to the class generically called "INSTL" files. Note that the rows' names are equal to the names of potential outputs which the user will see. For example, the name of the first row is BEDS; for each interactive EEWS session (for each installation), when a user requests equation results to be calculated, an output will appear indicating the number of BEDS at installations. Likewise, other outputs displayed will deal with ADMISSIONS, DAILY Average number of INPatients, and percent OCCUPANCY. But remember, unless a researcher requests that a value for BEDS be displayed as the output of an equation, no value will be shown in the output report line labeled BEDS. Thus, besides being the row names in the data base for each installation, DESCRIPTORS are also the names of possible outputs the user will see as a result of an EEWS session.

Notice that, across the top of Figure 3-5, the names of the columns (E1, E2, E3, etc.) in the INSTL file coordinate with the category names in the UNITYPE file (Figure 3-2). The column names in an INSTL file are the same as the category names in the UNITYPE file. In addition, although this Medical Topic Area matrix is large, most of the spaces are blank. An array which is not "rich" is a normal situation. To summarize, INSTL files have names of the possible outputs as the row names and the column names coordinate with the UNITYPE file categories, which are the equation inputs as indirectly requested by a user. When EEWS calculates results using an equation, it pulls the value of a term (i.e., a piece of data) from the location which is given by the name of the intersection of the row and column where the researcher has said that value should be

*For details, see the *EEWS System Maintainer's Manual*.

HEADQUARTERS, DEPARTMENT OF THE ARMY
WASHINGTON, D. C.
1 APRIL 1963

[illegible]

Figure 3-3. TO&E sample listing of personnel. (Source: TO&E [HQDA, April 1983].)

TABLE OF ORGANIZATION AND EQUIPMENT
TOE 17054J310
CHANGE 02
NMT, ARMED CAV BODN/ZZZ-09)

HEADQUARTERS, DEPARTMENT OF THE ARMY
WASHINGTON, D. C.
1 APRIL 1983

SECTION II

PARA	LINE/ LUN	CHG NO	SRC	DESCRIPTION	GRADE	MOB	BR	DCPC	ASU/NUMS				STRENGTH LEVELS						
									1	2	3	4	1	2	3	4	A	B	C
	080213		B	CAMOUFLAGE SCREEN SUPPORT SYSTEM WOODLAND/DESERT PLASTIC POLES								762	4	4	4	4			
	E08103		A	ELEC TRANSFER KEYING DEVICE ETAD KYK-13/TSEC									1	1	1	1			
	M87243		A	INSTALLATION KIT MK-1234/G F/AN/VRC-48 53 84 GRC125 180 IN M151									2	2	2	2			
	M87260		A	INSTALLATION KIT MK-1208/VRC-47 F/AN/VRC-47 IN M151									1	1	1	1			
	M87538		A	INSTALLATION KIT MK-1838/VRC F/KY-57 W/AN/VRC-48 IN M151A1									2	2	2	2			
	M87537		A	INSTL KIT MK-1838/VRC F/KY-57 W/AN/VRC-12 OR AN/VRC-47 IN M151A1									1	1	1	1			
	M87548		A	INSTL KIT MK-1848/VRC F/KY-57 W/AN/VRC-12 OR AN/VRC-47 IN M151A1									2	2	2	2			
	L44812		A	LAUNCHER GRENADE SMOKE SCREENING RED PHOSPHOROUS M228									2	2	2	2			
	L82112		A	MACHINE GUN CALIBER 50 VEHICLE HEAVY FIXED									2	2	2	2			
	L82352		A	MACHINE GUN 7.62 MILLIMETER FIXED									2	2	2	2			
	M04456		A	NIGHT VISION GOGGLES AN/PVS-5									4	4	4	4			
01	Q20835	01		DELETED															
	Q45778	01		DELETED															
	Q53001	01		DELETED															
	Q54174	01		DELETED															
	R21551	01	B	RADIOMETER IM-185/UD									1	1	1	1			
	S01373		A	SPEECH SECURITY EQUIPMENT TSEC/KY-57									8	8	8	8			
	T13166		A	TANK COMBAT FULL TRACKED 105MM GUN (TTS)									2	2	2	2			
	T61494	02	A	TRUCK UTILITY CARGO/TROOP CARRIER 1 1/4 TON 4X4 W/E (HMMWV)									2	2	2	2			

TOE 17054J310

2818

Figure 3-4. TO&E sample listing of equipment. (Source: TO&E [HQDA, April 1983].)

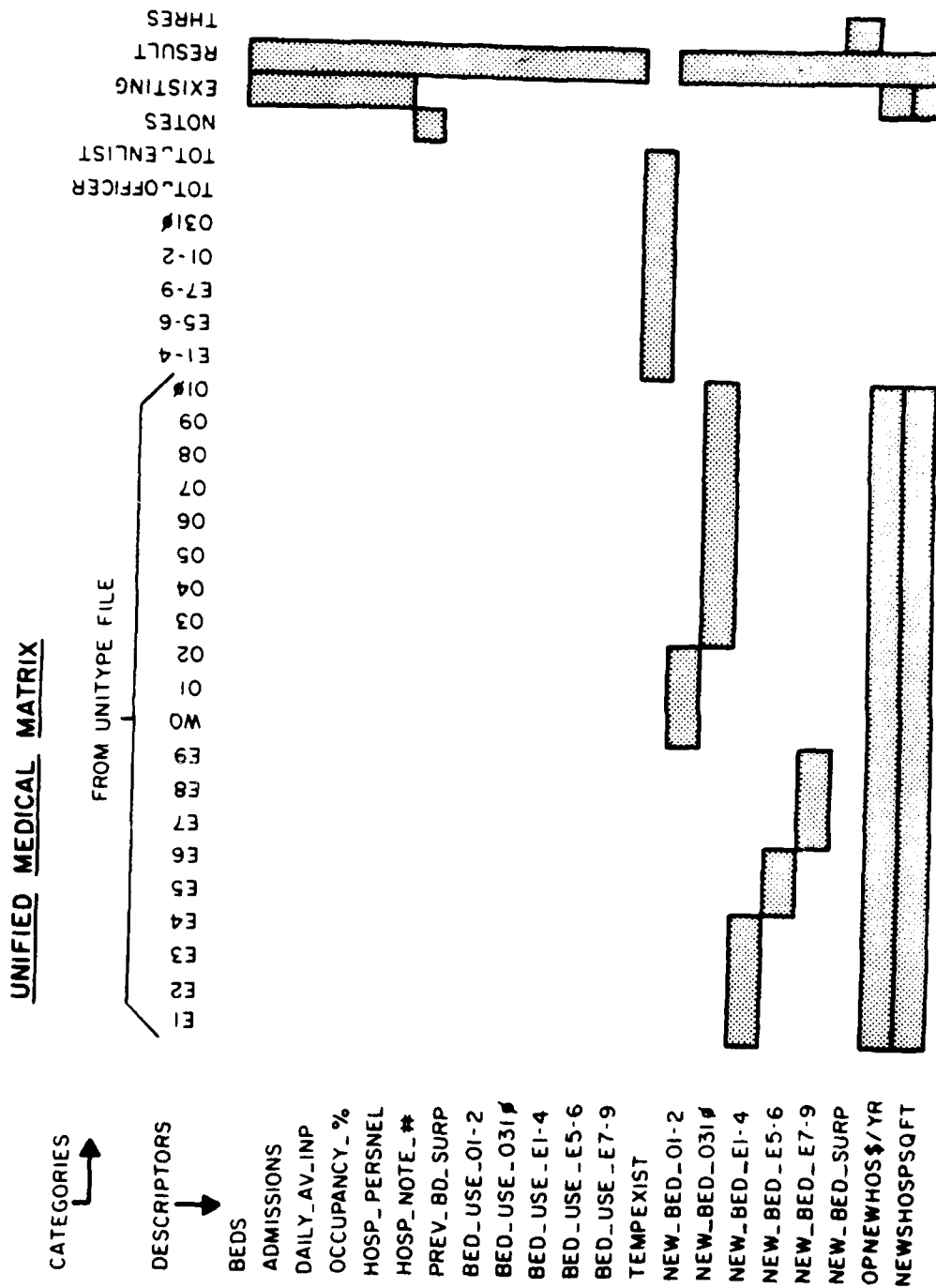


Figure 3-5. Medical Topic Area data storage format.

stored. Then, some operation (e.g., addition, multiplication) described in the equation is carried out on this piece of information. There is a two-dimensional INSTL matrix for each installation for each Topic Area. This setup is in contrast to the UNITYPE file, which is associated with no particular installation.

3.2.3 TYPICAL

Although each installation has one of the INSTL matrices dealing only with it, sometimes a researcher cannot find data about each installation. In fact, it is unusual to do so. On the other hand, a researcher often can find the average value for all installations--that is, a typical value for all installations. One INSTL-style matrix is named TYPICAL instead of a specific installation. TYPICAL is different in that when EEWS looks at a particular installation matrix and cannot find a piece of data, it will then go to the same location in the TYPICAL file and take the value located in a similar row/column instead. TYPICAL can be considered to contain the default value of a datum. To prevent EEWS from going to the TYPICAL file, a researcher can enter a zero into the installation's matrix. If he does, however, EEWS will use zero in the equation to calculate the result that will be displayed to a user.

A datum can be put into TYPICAL by two methods: (1) it can be entered into EEWS directly ("hardwired") as are data for any other installation (see the *EEWS Data Input Manual*) where a specific value is always desired or (2) the average of all data in a similar location for all installations can be stored instead. EEWS can calculate and store this value automatically. In either case, the researcher is responsible for deciding which action is appropriate based on the way his equations must act. He then informs the data loader which values to "hardwire" (per Chapter 6, section 6.4) or tells the system maintainer that the average value must be calculated.

3.3 Equations

There are two basic types of EEWS equations: algebraic and logical. Variations (TEMPorary equations) and combinations (logic equations that have algebraic portions) also exist. This section discusses these types and illustrates their usage with increasingly more involved examples. Most steps to writing an equation are discussed under *Algebraic Equations*, though the process and restrictions apply to all types.

3.3.1 Algebraic Equations

3.3.1.1 Equations That Display Data Only. The simplest type of equation just displays a piece of information from the EEWS data base. This type can be considered an algebraic equation with no operators. To display a piece of information to a user in the RESULTS report, a researcher *MUST* write an equation. In the example in Figure 3-6, the researcher wants to display the number of hospital beds at a particular installation. To display the number of beds, the equation must specify, "On the row which the user will see (which is called 'BEDS'), go to the column called EX(isting) and in that location, which is that row and column intersection, find the value of the existing number of beds available on-post. Pull that value out of the data base and make the RESULT of this equation (which is called 'BEDS,RES'), equal to that value." Researchers define the escriptors and often also define new categories if existing standard categories (i.e., EXisting, SURplus, and RESults) are not already available. Descriptor names are unique to a Topic Area. For example, HOUSING and NOISE may both have a descriptor called

IMPACT, but the meaning of IMPACT is entirely different between them. On the other hand, categories are usable by all Topic Areas and have the same meaning between them. Categories and descriptors can have the same or similar names (e.g., the category EX(isting) and the descriptor TEMPEXIST(ing) as in Figure 3-7). However, a researcher must remember that they are used completely differently and are NOT interchangeable at any time. The value which is an equation RESult will be displayed to the user. This is the simplest form of equation; it does nothing except display information. Changes in troop reallocations made by the user in an EEWS session have no effect on the equation result because there are no UNITYPE input terms. In addition, had a researcher not written an equation, that is, had EEWS contained only a row called BEDS without an equation to generate a resultant value, EEWS would not have had a method of displaying a value for the descriptor called BEDS to the user at any installations for which he had requested output.

Notice that in Figure 3-6, in the row on the form labeled "Data Source," the exact source of that piece of information is stated; it is from the American Hospital Association (AHA), *Guide to Health Care Institutions*. The value for BEDS is from the column called BEDS for each of the AHA's listed locations. The source of every bit of data EEWS uses MUST be stated explicitly down to the row and column (if appropriate) because a data input technician will not have the expertise to find it later. The INSTL data are input individually for each installation according to the format described in Chapter 6.

3.3.1.2 Equations That Manipulate Data. In EEWS equations, data are manipulated using OPERATORS. Table 3-1 gives the complete list of possible EEWS algebraic operations.

To show how EEWS equations work, Figure 3-7, the New Surplus Square Feet of Medical Facilities form, will be used to show a slightly more complicated equation than in the last section, but one which is more like the format of a normal EEWS equation; it calculates the effects of reallocations a user might make among installations.

3.3.1.2.1 How to Go From a Flowchart Decision Point to EEWS Form (or How to Know What Someone Else's Equation Is Doing). The result desired from the algebraic equation in Figure 3-7 is the New Surplus Medical Facilities in Square Feet--"NEWSHOSPSQFT." Thus, the first step for a researcher is to define the name of the resultant descriptor and place it in its box at the upper left of the form. Next, the General Equation (top left middle of the form) is written. It states in English words what the equation is to look like. In taking the step from the General Equation to Specific Equation, the researcher puts his equation into a format a little more closely related to the format in which it will be when the data loader submits it to EEWS. A researcher can combine both steps if that makes the developmental process easier and clearer. The Equation Form is designed to help a researcher write and document his equation development. If the equation is already straightforward, the researcher need not bother with the Specific Equation. In this case, however, the Specific Equation box is filled in. It says, "Take the negative of the value of the existing hospital capacity, divide it by the value of the total number of officers and enlisted personnel at the installation, and multiply that by the sum of new personnel which the user is thinking of moving into the installation(s) he has requested." This statement is still a long way from the jumble of symbols in the area labeled "Input to EEWS," but since it is difficult to read and understand that middle portion, the Specific Equation section helps bridge the gap.

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Figure 3-7. Completed ERWS Equation Form: SQ FT OF MEDICAL.

15 Oct 84

NAME		T UNIT TYPE	
EQUATION NAME		A E 4 + E 5 + E 6 + E 7 + E 8 + E 9 + W 0 + D 1 + O 2 + O 3 + O 4 + O 5 + O 6 + O 7 + O 8 + O 9 + O 1 0	
EQUATION ABBREVIATION			
EQUATION SUBGROUP & NAME			
EQUATION DESCRIPTION/EXPLANATION/NOTES			
EQUATION INPUT NAME			
EQUATION OUTPUT NAME			
EQUATION SUBGROUP & NAME			
EQUATION DESCRIPTION/EXPLANATION/NOTES			
SPECIFIC VALUES FOR PORT			
SAMP. E			
CALC			
SUBTOTAL			
CHECK			
PARENTHESES			
EQUATION NAME			
EQUATION ABBREVIATION			
EQUATION SUBGROUP & NAME			
EQUATION DESCRIPTION/EXPLANATION/NOTES			
EQUATION INPUT NAME			
EQUATION OUTPUT NAME			
EQUATION SUBGROUP & NAME			
EQUATION DESCRIPTION/EXPLANATION/NOTES			
SPECIFIC VALUES FOR PORT			
SAMP. E			
CALC			
SUBTOTAL			

Figure 3-7. (Cont'd)

Table 3-1
Algebraic Operations Allowed in EEWS

+	Addition
-	Subtraction (or change the sign of...)
*	Multiplication
**	Exponentiation
/	Division
(Begin parenthesis
)	End parenthesis

In addition, there is an easy way to understand EEWS equations in detail. Anyone can determine what the equation does and how it does this by looking at the lower portion of the form in the section labeled "Equation Subgroup and Name/Description/Explanation/Notes." Here the researcher checks to insure the equation he has written in the lines above actually functions as he thinks it should. After he has formed the equation to be input to EEWS, he does this by congregating its terms. In addition, this section allows anyone else to understand in detail the purpose of the operations without needing to consult the researcher. For example, when the researcher congregates the first three terms of the equation in Figure 3-7, he obtains a percentage. By adding the last several terms from the UNITYPE file, he finds the total new personnel. When the two values are multiplied together, the result is the increased demand. Finally, he takes the negative of the demand to phrase the result as a surplus.

3.3.1.2.2 Relationship of an Equation With the Data Base. Notice that a small version of the INSTL file (labeled "Conceptual Matrix") is located in the upper right corner of the Equation Form. On the small matrix, inputs appropriate to this equation, which come from the UNITYPE file (shown in Figure 3-2), are names of the columns. Possible outputs to a user are the row names (e.g., NEWSHOSPSQFT).

The small matrix has a row called "TEMPEXIST(ing)." Values from this row will not be displayed to a user because the researcher never wrote an equation that set the location (TEMPEXIST,RES) equal to a value.* For the descriptor NEWSHOSPSQFT, the researcher has stated that, "In order to calculate the desired value, EEWS must first pull a datum from a location which is the intersection of the row called TEMPEXIST and the column called TOT_OFFICER."

*In addition, the researcher has repressed the printing of even the descriptor name in the output reports by naming the descriptor TEMP_____ as described in Section 3.3.3. This is a common action to take for descriptors that store only data and that would have

The Conceptual Matrix in Figure 3-7 is actually a condensed version, specific for this particular equation, of the entire Medical Topic Area INSTL matrix shown as the Unified Medical Matrix in Figure 3-5. Most of the time, if a Topic Area will contain a complicated series of equations, it is clearer and easier to summarize the data locations that all equations within a Topic Area will need as a "Unified Matrix" (as in Figure 3-5) rather than on the little individual conceptual matrix on each equation sheet (as in Figure 3-7). The researcher must show his descriptors either on the Conceptual Matrix or on the Unified Matrix; it is from one of these sources that the data loader will input descriptors and categories associated with a Topic Area.

Results of ALL equations are automatically placed in the row with the descriptor's name and the column RES. A researcher cannot place an output result in any other column (such as SURP).

3.3.1.2.3 Completing the "Input to EEWS" Section (and Reading an EEWS Equation). The actual equation that does the manipulations within EEWS is located on the three lines labeled "EEWS File Name," "Location Abbreviation in File," and "Topic Area." In Figure 3-7, the file from which the researcher will pull the first bit of information (after the equation result) is the INSTL file. Data from the INSTL file will be different for each installation; if the installation of interest does not contain a datum in its own file, the system will look into the TYPICAL file automatically to see what value is available there.

How does a researcher let EEWS know that the first term in Figure 3-7 is from an installation's file rather than from another type of file? First, EEWS pulled the datum from the installation's file because that information is installation-specific--so it is labeled INSTL. Second, the datum has a row name AND a column name. All Army unit (UNITYPE) data have only one locator because the file has only one dimension (it is a list).

What is the process by which the computer finds the value of the first term (Existing Hospital Square Feet) using the instructions the researcher has developed? It first finds the INSTL data file for the installation a user has requested, such as Fort Bliss. It goes to the row that has been labeled NEWSHOSPSQFT, and then over to the column called EXisting. At the matrix location (INSTL,NEWSHOSPSQFT,EX), Fort Bliss's datum would be stored. This location has been darkened in Figure 3-5. A different value would be located there, if instead, the researcher were examining the installation file which contains data for Fort Carson.

Within the equation, after finding the numerical value of the first term in the data base, EEWS carries out some operations; it closes the first term with a right parenthesis and then divides. The second term is also from a file dealing with an installation; it is from the row the researcher has called "TEMPEXIST(ing)" and the column he has called "TOT OFFICER" (total number of officers). To find the datum within that installation's data file, EEWS will find the intersection of the row called TEMPEXIST and the column called TOT OFFICER where that piece of information is located. Similarly, with the third term (which is also from an installation-specific file), EEWS will go to a matrix row/column location.

If a researcher needs to use a datum from a row other than that which the descriptor defines in the equation, he may define a row that never has any outputs displayed through an equation (e.g., the row TEMPEXIST as described above). For example, in the NEWSHOSPSQFT equation, a researcher says, "Get the piece of information which is the 'EXISTing' amount of Total Enlisted Personnel at an installation."

Why would a researcher want to use a total rather than input individuals and then total them through a series of operations within an EEWS equation? A researcher could write an equation to total the different individuals, but, as in this example, a data source exists in which that value is already totaled. So why bother? In the researcher's opinion, the additional data storage space is small compared to the cost of calculating its value using an EEWS equation.

The next term the researcher has used is different from the previous terms because it is NOT from an installation's file. Up to now, the researcher has "characterized" installations because he has pulled data from file locations that relate specifically to installations (INSTL-type files). But the next term deals with a UNITYPE file datum. It says, "We are making changes at this installation. Stand at attention! This is where the inputs which a user may potentially request can affect the result of this equation." It is at this point that EEWS becomes valuable to the user; here, the changes made by the user in his EEWS session will be input into an equation to produce effects that may be of concern to him. In this case, inputs that may affect the results of the equation are the numbers of enlisted persons and officers that may be moved onto or off of the installation. Unlike the TOT OFFICER and TOT ENLIST data, which are installation-specific pieces of data from DD Form 1657, there are no previously summed values for enlisted persons and officers from the UNITYPE file, so the researcher actually adds together all grades of personnel to find the value for total personnel.

3.3.1.2.4 Why Put Equations on a Particular EEWS Form? (and How an Equation Is Input). Why is there a need for equations in the format shown in Figure 3-7? Figure 3-8 shows the way in which a data loader would take the information in Figure 3-7 and submit it to EEWS. Note that, as the data loader proceeds through Figure 3-8, he is pulling out items from the Equation Form in Figure 3-7 that are on the six rows labeled INPUT TO EEWS. EEWS is asking, "What is the name of the row?" The name of the row is NEWSHOSPSQFT. "What is the operation?" The operation is "take the opposite of..." (the negative sign). "What is the next operation?" A beginning parenthesis. "What is the next operation?" At this question, the data loader enters an EXIT and EEWS knows it is time to stop entering operations and to enter a term instead. The term describes the location from which information is to come. For this equation, EEWS is to pull a value from an installation's INSTL file; the row name is NEWSHOSPSQFT and the column name is EX(isting). The Topic Area in which the datum is located is MEDICAL. All of that information is input for the first term in Figure 3-7. Still, it is only a portion of what the equation loader will eventually give the computer. He will input Topic Area, Topic Area Prerequisite, Equation Resultant Descriptor, EEWS File Name, Location Abbreviation in File, Full Name, Units of Measure, Data Source, and Note for Terms data. In addition, the Specific Values indicated at the bottom of Figure 3-7 for an installation will be input to insure that the computer is producing the same results expected from the Sample Calc. line.

Thus, the different sections of an EEWS Equation Form insure the equation is written logically. When a researcher completes a form, the form contains essentially complete documentation of the research done on this particular equation and is also the form used by a data loader.

3.3.1.2.5 The Notes Form. Since the Data Sources portion can be repetitious and since the area for the Criteria for Entire Equation box may not be large enough, a supporting Notes Form (Figure 3-1c) has been developed. The researcher is assigned a series of reserve note numbers available for his Topic Area only. On the Equation Form, the researcher assigns one of these note numbers to a Data Source or Criteria block on the Equation Form and then completes one Notes Form for each different statement or

COMMAND	OPERATION
INPUT, TOPIC, DESCRIPT	.
TOPIC AREA	OPERATION
MEDICAL	EXIT
DESCRIPTOR	TERM NUMBER 3
NEWSHOSPQFT	FILE NAME, DESCRIPTOR AND OR CATEGORY
LINE NUMBER	INSTL, EX, TOT, OFFICER
144	TOPIC AREA
FILE NAME	MEDICAL
NEW COURSES OF MEDICAL FACILITIES	OPERATION
DATA SOURCE	OPERATION
FACILITIES ENGINEER'S SUMMARY HOUSING REPORTS	.
UNIT IS MEASURED	OPERATION
OF	.
DESCRIPTOR	OPERATION
RETURN	.
COMMAND	OPERATION
INPUT, TOPIC, EQUATION	EXIT
TOPIC AREA	TERM NUMBER 4
MEDICAL	FILE NAME, DESCRIPTOR AND OR CATEGORY
RESULT DESCRIPTOR	UNITYPE, E1
NEWSHOSPQFT	OPERATION
OPERATION	.
OPERATION	OPERATION
EXIT	EXIT
TERM NUMBER 1	TERM NUMBER 5
FILE NAME, DESCRIPTOR AND OR CATEGORY	FILE NAME, DESCRIPTOR AND OR CATEGORY
INSTL, NEWSHOSPQFT, EX	UNITYPE, E2
TOPIC AREA	OPERATION
MEDICAL	.
OPERATION	OPERATION
OPERATION	EXIT
OPERATION	TERM NUMBER 6
OPERATION	FILE NAME, DESCRIPTOR AND OR CATEGORY
EXIT	UNITYPE, E3
TERM NUMBER 2	OPERATION
FILE NAME, DESCRIPTOR AND OR CATEGORY	.
INSTL, EX, TOT, OFFICER	OPERATION
TOPIC AREA	EXIT
MEDICAL	TERM NUMBER 7
OPERATION	FILE NAME, DESCRIPTOR AND OR CATEGORY
OPERATION	UNITYPE, O10
EXIT	OPERATION
TERM NUMBER 3	.
FILE NAME, DESCRIPTOR AND OR CATEGORY	OPERATION
INSTL, EX, TOT, OFFICER	EXIT
TOPIC AREA	TERM NUMBER 8
MEDICAL	FILE NAME, DESCRIPTOR AND OR CATEGORY
OPERATION	EXIT
OPERATION	NOTE NUMBER?
OPERATION	55
.	TOPIC AREA
	EXIT

Figure 3-8. Input of an EEWS equation.

source. This procedure is convenient for the researcher because it avoids repetitious entries; it is convenient for the equation loader since, during a loading session, EEWS requests notes (and assigns them numbers) before the equation is input. In the equation, the data loader actually refers to the note number (as in Figure 3-8).

Several types of notes are entered on these forms:

1. Specific to equations, notes deal with the--
 - (a) Descriptor (the "DATA SOURCE" in Figure 3-8), which is a summary of all SOURCES used in the equation
 - (b) Equation (the "NOTE NUMBER" at the end of Figure 3-8), which is a summary of the CRITERIA on which the equation is based.
2. Specific to pieces of data are the:
 - (a) Data sources (the "DATA SOURCE" under each term in Figure 3-7, but input when the individual data values are entered because it may vary among several sources)
 - (b) Data values which are stored in TYPICAL rather than INSTL files. These should also have a data source input.

3. Notes specific to an entire Topic Area. In this case, a descriptor will have a name in the form NOTE_XXXXXXX (e.g., in the Endangered Species Topic Area, the descriptors called NOTE_#_INSTL and NOTE_LEGEND per Figure 7-1 in Chapter 7). In this case, EEWS will see the NOTE prefix on the descriptor and print the contents stored under the reference note number for the installation in question. These notes usually are long lists of additional background information that will not change with a user input (see Figure 3-9). In this case, the researcher must write an equation to display the note values to the user (much like the equation in Figure 3-6).

3.3.1.2.6 Requesting an Equation Stored in EEWS. Once the data loader saves an equation, a printout can be requested (Figure 3-10). Researchers and data loaders use this listing to insure that the equation is stored correctly. It is not easily understandable in this form, however, which is why an EEWS Equation Form is used for documentation.

3.3.1.2.7 Modifying an Equation Already Stored in EEWS. Once a researcher writes an equation, he may need to modify it--an easy process. Figure 3-11 shows how equation terms or operations can be changed. Although it is possible to make modifications after the equation is loaded on the computer, a researcher should try to do it right the first time because it is much easier to deal with that way.

3.3.1.2.8 Using the Results of Other Equations. Note that the equation in Figure 3-7 is a straightforward calculation done in only one step--that is, in one equation. In EEWS, it is possible to do calculations in more than one step. In fact, several steps often are needed to determine a final desired result. When a flowchart has been generated (as in Figure 2-2), many of its steps may indicate that an EEWS equation will need to access and use the results of a previous step. How is this done? A researcher writes an equation to produce a result; when a result is calculated, it is stored automatically in the location that has the name of the descriptor as the row (e.g., NEWSHOSPSQFT) and the name of the column where results are stored during a user submission (RES). Thus, for the example, a value is placed in the installation's file at the matrix location: (INSTL,NEWSHOSPSQFT,RES,MEDICAL). If a researcher wants to use a value after it has been calculated as indicated in the flowchart (but not before, he can

NOTE NO. 214

HOOD

	ROC	HT	POC	Sea	#AC	PP	#ON	F	ST	RPot	Taxy	DThr
SP1 = Texas kangaroo rat - <i>Dipodomys elator</i>	0	1	0	1	1	1	1	-	T	H	2	3
SP2 = Bald eagle - <i>Haliaeetus leucocephalus</i>	4	2	2	4	1	3	2	E	E	H	3	1
SP3 = Peregrine falcon - <i>Falco peregrinus</i>	4	2	2	2	1	3	2	E	E	H	2	1
SP4 = Osprey - <i>Pandion haliaetus</i>	4	2	2	4	1	2	2	-	T	H	2	1
SP5 = Whooping crane - <i>Grus americana</i>	3	3	4	2	1	2	1	E	E	L	2	3
SP6 = Least tern - <i>Sterna antillarum antillarum</i>	2	1	2	5	1	1	1	-	E	L	1	2
SP7 = Wood stork - <i>Mycteria americana</i>	2	2	2	1	1	1	-	T	L	3	2	
SP8 = Golden-cheeked warbler - <i>Dendroica chrysoparia</i>	4	1	4	5	3	1	4	-	T	H	2	2
SP9 = White-faced ibis - <i>Plegadis chihi</i>	2	2	2	1	1	1	1	-	T	L	3	2
SP10 = Blue sucker - <i>Cypleptus elongatus</i>	2	1	2	6	1	1	1	-	T	L	2	1

NOTE NO. 210

RARE, ENDANGERED AND THREATENED SPECIES TOPIC AREA
LEGEND FOR NOTES FILES FOR ALL INSTALLATIONS

ROC...Reliability of Occurrence:

- 1...not verified from the installation and once reported from the general area, but now probably extinct
- 2...not verified from the installation, and its presence therefore unlikely due to marginal habitat and/or few and irregular recent reports (Wanderers)
- 3...not verified from the installation, but undoubtedly present on a sustained basis due to available habitat and/or numerous and regular, peripheral reports
- 4...verified presence on the installation

HT...Human Toleration:

- 1...tolerate well man's presence
- 2...moderately wary of man's presence
- 3...extremely wary of man's presence

Figure 3-9. Endangered Species notes output.

POC...Place of Occurrence

- 2...occurs primarily in inaccessible areas
- 4...occurs about equally in training and non-training areas
- 6...occurs primarily in active training areas

Sea...Season:

- 1...wanderer or accidental
- 2...migrant or transient
- 3...winter resident only
- 4...winter resident and migrant
- 6...resident

#AC...Number of installation Acres species currently found on:

- 1...0-5% of total installation acres
- 2...5-10% of total installation acres
- 3...10-25% of total installation acres
- 4...25-50% of total installation acres
- 5...50-100% of total installation acres

PP....Population Parameter:

- 1...small acreage required for a viable population (0-100 acres)
- 2...medium # acres required for a viable population (100-1000 acres)
- 3...numerous acres required for a viable population (1000+ acres)

F...Federally protected:

- 3...ENDANGERED
- 2...THREATENED
- 1...RARE

ST...STATE-protected:

- 3...ENDANGERED
- 2...THREATENED
- 1...RARE

RPot...Recovery Potential:

- 1...Low
- 2...High

Taxy...Taxonomy:

- 1...subspecies
- 2...species
- 3...monotypic genus

DThr...Degree of Threat

- 1...Low
- 2...Moderate
- 3...High

Figure 3-9. (Cont'd)

COMMAND?
LIST, TOPIC, EQUATION

TOPIC AREA?
MEDICAL

SHORT DESCRIPTOR?
NEWSHOSPSQF

THERE MAY BE A LARGE VOLUME OF PRINTED OUTPUT.
PRINT AT TERMINAL (T) OR PRINTER (P)?
(PAPER PRINTING BEGINS AFTER YOU GET OUT OF EEWS,
TERMINAL DISPLAY BEGINS IMMEDIATELY)

T

EQUATION LISTING

```

TOPIC AREA=      5 (MEDICAL
DESCRIPTOR=     199 (NEWSHOSPSQF )
NOTE NUMBER=      13

OPERATION(S) = - (
TERM# 1, FILE=INSTL , ROW= 199(NEWSHOSPSQF ), COL = 600(EX
TOPIC AREA = 5 (MEDICAL
OPERATION(S) = ) / ( (
TERM# 2, FILE=INSTL , ROW= 32(EX ), COL = 2(TOT_OFFICER
TOPIC AREA = 5 (MEDICAL
OPERATION(S) = ) + (
TERM# 3, FILE=INSTL , ROW= 32(EX ), COL = 16(TOT_ENLIST
TOPIC AREA = 5 (MEDICAL
OPERATION(S) = ) ) * (
TERM# 4, FILE=UNITTYPE, , COL = 1 (E1
OPERATION(S) = +
TERM# 5, FILE=UNITTYPE, , COL = 3 (E2
OPERATION(S) = +
TERM# 6, FILE=UNITTYPE, , COL = 5 (E3
OPERATION(S) = +
TERM# 7, FILE=UNITTYPE, , COL = 39 (O10
OPERATION(S) = )

```

Figure 3-10. EEWS equation listing.

```

COMMAND?
MODIFY TOPIC EQUATION
  TOPIC AREA?
MEDICAL
  SHORT DESCRIPTOR?
NEWSHOSPSQF
  DELETE EQUATION?
N
  ADD, DELETE, CHANGE OR EXIT?
CHANGE
  TERM# OR OPERATION(S)?
P
  TERM NUMBER?
1
  FILE NAME
UNITYPE
  COLUMN (CATEGORY)?
E7
  ADD, DELETE, CHANGE OR EXIT?
RETURN
MODIFIED EQUATION SAVED

COMMAND?
LIST TOPIC EQUATION
  TOPIC AREA?
MEDICAL
  SHORT DESCRIPTOR?
NEWSHOSPSQF
  THERE MAY BE A LARGE VOLUME OF PRINTED OUTPUT
  PRINT AT TERMINAL (T) OR PRINTER (P)?
  PAPER PRINTING BEGINS AFTER YOU GET OUT OF EEWS.
  TERMINAL DISPLAY BEGINS IMMEDIATELY.
T
  EQUATION LISTING
  -----
  TOPIC AREA=      5 (MEDICAL
  DESCRIPTOR=     199 (NEWSHOSPSQF )
  NOTE NUMBER=      13

  OPERATION(S) = +
  TERM#  1, FILE=INSTL , ROW= 199(NEWSHOSPSQF ), COL = 600(EX
  TOPIC AREA = 5 (MEDICAL
  OPERATION(S) = +
  TERM#  2, FILE=INSTL , ROW= 32(EX          ), COL = 2(TOT OFFICER )
  TOPIC AREA = 5 (MEDICAL
  OPERATION(S) = +
  TERM#  3, FILE=INSTL , ROW= 32(EX          ), COL = 16(TOT ENLIST

  TOPIC AREA = 5 (MEDICAL
  OPERATION(S) = +
  TERM#  4, FILE=UNITYPE, COL = 1 (E1
  OPERATION(S) = +
  TERM#  5, FILE=UNITYPE, COL = 3 (E2
  OPERATION(S) = +
  TERM#  6, FILE=UNITYPE, COL = 5 (E3
  OPERATION(S) = +
  TERM#  7, FILE=UNITYPE, COL = 13 (E7
  OPERATION(S) = +

```

MODIFYING: CHANGE LAST TERM
FROM 010 TO E7

← LISTING CHANGED EQUATION

← E7, NOT 010

Figure 3-11. EEWS equation modification.

refer to the specific matrix location (i.e., in this example, INSTL,NEWSHOSP-SQFT,RES,MEDICAL) and use that item of information as if it were an ordinary datum for input to a term in another equation (the next step in his flowchart). A researcher can continue extracting information from the matrix as long as the equations are in sequential order. In this way, the researcher can "boot-strap" his data to more and more sophisticated levels of output.

3.3.1.2.9 Using Data From Outside the Current Topic Area. Often a researcher will find that the data he needs to run his equations already exists within the EEWS data base, but in another Topic Area. A datum can be accessed from Topic Areas outside the current one; for example, information stored in the INSTL data base can be called using the form:

(INSTL,DESCRIPTOR,CATEGORY,OTHER_TOPIC_AREA)

Results of previously calculated equations also can be used by referring to them in the form:

(INSTL,DESCRIPTOR,RES,OTHER_TOPIC_AREA)

However, the second case requires that the data loader be told your Topic Area must have another Topic Area calculated first as a prerequisite (see the *EEWS Data Input Manual*).

3.3.2 Logic Equations

EEWS can also deal with logical evaluations. Figure 3-12 shows the general form, which is: "IF (so and so) THEN (something) ELSE (something else)." In a logic statement, the researcher bifurcates all possibilities. The answer (INSTL,DESCRIPTOR,RES,-TOPIC_AREA) can be a number value or a YES or NO (section 3.4). If the logical statement (the "so and so") is true, the value stored as RES is given in the "THEN (something)" part. If the "so and so" is not true, the value stored as RES is given in the "ELSE (something else)" part. This entire logical statement (IF/THEN/ELSE) is all one equation. An example of the process of using algebraic results in a logical evaluation is documented on the Equation Form (Figures 3-13 and 3-14 show examples). First, inputs from the UNITYPE file are summed to obtain a number which is stored in the RES column for this descriptor (Figure 3-13). This simple algebraic equation yields the total number of tactical equipment pieces that may be involved in a user reallocation. In Figure 3-14, which shows a logic equation, the researcher uses the algebraic result from the equation in Figure 3-13 as input for the first term to the logic equation. Figure 3-14 says: "Add the result of the tactical equipment equation (Figure 3-13) plus the result of a similar equation that totaled the number of movable weapons, plus the result of another equation that deals with transportation equipment, etc. IF the result of adding those values (i.e., all items between the parentheses) is greater than zero, (i.e., if more pieces of equipment have been moved into the installation than out of it), THEN the user has moved additional equipment onto the installation. In such a case THEN, the result of the maneuver area equation that will be displayed to the user will be the word YES (the word will appear if EEWS sees that RES is equal to that very strange number)."

Here the researcher is using a very strange number to obtain word outputs as well as number outputs (section 3.4). However, if the expression within the IF portion is not true, the THEN would not be appropriate, so EEWS should put into the RES column

Algebraic equations always give a numerical answer which results from a combination of variables:

$$\begin{aligned}A + B &= C \\2 + 2 &= 4\end{aligned}$$

These algebraic equations can only tell what a term is equal to. They cannot compare the value of one term to another.

Unlike algebraic equations, logic equations can be used to answer "yes" or "no" questions or to check if a variable or combination of variables are less than (LT), greater than (GT), less than or equal to (LE), greater than or equal to (GE), and (AND), or (OR), equal to (EQ), and not equal to (NE) some other variable or constant.

The standard form of a logical equation is:

```
(ROW NAME,RES) =  
  IF (expression)  
    THEN (value or algebraic expression)  
    ELSE (value or algebraic expression)
```

EXAMPLE 1:

```
TACTICAL,RES =  
  IF ((TACTICAL,EX) GT 0.0)  
    THEN 1.0  
    ELSE 0.0
```

Example 2:

```
(MVR_AREA,RES) =  
  IF ((TACTICAL,EX) GT 0.0) OR ((TRANS,EX) GT 0.0)  
    THEN ((TACTICAL,EX) + (TRANS,EX)) * 43560  
    ELSE 0.0
```

Figure 3-12. Logical statements.

51

51

Figure 3-14. Example logic equation.

whatever the ELSE part states is appropriate. In this case, if the sum of all new equipment used in maneuver areas is equal to or less than zero, the demand on maneuver areas at this installation will not increase, therefore, there is no need to raise a flag (section 3.4 describes how to raise flagwords).

Figure 3-15 lists some basic rules for the IF/THEN/ELSE statements. Figure 3-16 shows how a logic equation is input into EEWS; this figure should clarify why a researcher must have the Equation Form completed in full.

3.3.3 Temporary Equations

The result of every equation will always appear to the user as output for each installation of interest in a user session *unless* the equation is "temporary." Temporary equations are interim steps in the Topic Area flowcharts which would have little meaning to a user if he were to see them and which may, in addition, be confusing. Temporary equations do tests or generate sums or coefficients which are then used in a later step. They are written exactly as are any other equations (either algebraic or logical), except that the descriptor/row name begins with the letters "TEMP." The rest of the name can be anything the researcher wishes--up to eight additional spaces after TEMP. Figure 3-17 is an example of a formatted temporary equation that generates a coefficient to be used later as a value in the INSTL file. The equation name illustrates the standard form of telling EEWS that this result will not be displayed to the user:

INSTL,TEMP _ _ _ _ _ ,RES, TOPIC AREA.

3.4 Flagwords

A researcher can display certain flagwords to the user in the places where calculated numerical results usually are presented (such as was shown in Figure 3-14). The purpose is to make the reports more understandable to the user by presenting information in words rather than just numbers. These flagwords are presented in the MODEL and LIST options during an EEWS session (the actual values used to display them to the user are printed in the MODIFY option).

The flags are defined by numerical values that are used like constants in equations--particularly logic equations. These values and corresponding text outputs are given in Table 3-2.

Descriptor results or existing data, which are numerically equal to any of these values, will be displayed as their corresponding text equivalents in the output generated by MODEL and LIST.

These flags can be used in equations to generate text output instead of numbers for appropriate descriptors. For instance, you might wish to output the word "PROBLEM" as the result for the descriptor "ONTIDALWATS" if an installation encompasses tidal waters or the word "NO" if it does not. To do this step, you could use the following equation:

```
(INSTL,ONTIDALWATS,RES,COASTALZONE) =
IF ((INSTL,ONTIDALWATS,EX,COASTALZONE) EQ 1.0)
    THEN -3000000000000000
    ELSE +3000000000000000
```

1. The following operations are valid for EEWS equation input:
`IF THEN ELSE AND OR GT EQ LT NE GE LE`
2. IF - THEN - ELSE must either not appear in an equation or they must all appear in the order IF -- THEN -- ELSE.
3. AND and OR can only be used to separate two clauses that each contain one of the following: GT EQ LT NE GE LE.
4. The operators AND OR GT EQ LT NE GE LE can only appear between the operators IF and THEN, i.e. logical statements cannot be imbedded in the result part of a logical statement (though an algebraic expression can be).
5. The operators AND OR GT EQ LT NE GE LE can only be used in an equation that contains the operators IF THEN ELSE.
6. Only one set of IF -- THEN -- ELSE can appear in an equation and all three parts (IF-THEN-ELSE) must appear. Both the THEN and ELSE must appear because they set the RES and the result of every equation must be defined.
7. Multiple AND and OR operators are permitted in an equation.
8. For all equations a particular result can only be calculated once since all equations must be consecutive, i.e. DO LOOPS are not allowed.
9. The above rules/restrictions are valid for both temporary and permanent equations.

Figure 3-15. Basic rules for writing EEWS logic equations.

The equation to be solved is:

```
IF (INSTL,E131BROF,RES,HOUSING) GT 20 0)
  THEN UNITYPE,E1 * INSTL,PMAR,E1,HOUSING
  ELSE 0.0
```

The EEWS input stream is similar to this:

COMMAND?
>INPUT,EQUATION,TERMS

TOPIC AREA?
>HOUSING

RESULT DESCRIPTOR?
>E133BROF

OPERATION?
>IF

OPERATION?
>EXIT

FILE NAME, DESCRIPTOR AND/OR CATEGORY?
>INSTL,E131BROF,E1,HOUSING

TOPIC AREA?
>HOUSING

OPERATION?
>GT

OPERATION?
>EXIT

FILE NAME, DESCRIPTOR AND/OR CATEGORY?
>CONSTANT,20 0

OPERATION?
>THEN

OPERATION?
>EXIT

FILE NAME, DESCRIPTOR AND/OR CATEGORY?
>UNITYPE,E1

OPERATION?
>*

OPERATION?
>EXIT

FILE NAME, DESCRIPTOR AND/OR CATEGORY?
>INSTL,PMAR,E1,HOUSING

OPERATION?
>ELSE

OPERATION?
>EXIT

FILE NAME, DESCRIPTOR AND/OR CATEGORY?
>CONSTANT,0 0

OPERATION?
>EXIT

FILE NAME, DESCRIPTOR AND/OR CATEGORY?
>EXIT

Figure 3-16. Input stream for an EEWS logic equation.

```
(TEMPPRODCOEFF, RES) =
```

```
IF ( (PRODWAT, RES) / (PURCWAT, RES) ) GT 1.00  
  THEN 1.00  
  ELSE 0.00
```

This equation is used to determine whether the amount of water produced is greater than the amount of water purchased at an installation. The result of this equation will be multiplied with another term in the next step of the flow chart for this topic area. This equation implies if the produced water is the greater value, the researcher will want to save the term in question in the next step. If the purchased water amount is the greater value, the term in the next step will be multiplied by zero, thus it will be dropped from further consideration. In either case, neither the result nor the descriptor of this equation, TEMPPRODCOEFF, will be displayed to the user.

Figure 3-17. Example temporary equation.

Note: when you are writing equations, take care to account for the possibility that an existing data element or previously computed result may contain one of these flags rather than meaningful numerical data. Thus, if an equation attempts to perform any arithmetic operations (addition, subtraction, multiplication, division, or exponentiation) on terms which are numerically equal to any of these flags, the term will be set to zero and the rest of the equation will continue to be calculated.

3.5 Preventing Division by Zero and Strange Manipulations

Many times equations will not work correctly because a division by zero or other strange manipulation has occurred. These situations can occur in several ways and the researcher **MUST** insure that his Topic Area is set up in a way to avoid them all. The most common cases to protect against are:

1. No data are available for an installation. In this case, NO DATA (the value -10000000000000000) must be stored or EEWS will use the corresponding value stored in the TYPICAL file.

2. No value has been stored in TYPICAL because the researcher did not tell the data loader or system maintainer, respectively, what the value was to be or that the data base average was to be used (see Chapter 4, section 4.1).

Table 3-2

EEWS Flagwords and Their Corresponding Values

Flag Value	Output	Effect
¹⁵ -1x10	NO DATA	Raises Flag in Summary Reports
¹⁵ -2x10	NONE	
¹⁵ -3x10	PROBLEM	
¹⁵ -4x10	SUBINSTL	
¹⁵ -5x10	PRESENT	
¹⁵ -6x10	MEANINGLESS	
¹⁵ -7x10	ZERO DIVIDE	
¹⁵ -8x10	YES	
¹⁵ -9x10	NO	
¹⁵ +1x10	NO PROBLEM	Raises No Flag in Summary Reports
¹⁵ +2x10	YES	
¹⁵ +3x10	NO	
¹⁵ +4x10	NO DATA	

3. The data value is truly zero. (NO DATA and zero are completely different concepts.) This case is entirely possible and happens often in two ways:

(a) The equation requires a user input and that input is zero; for example, the user inputs to EEWS some E2s but no E1s. EEWS supplies those data to an equation as:

$$(UNTYPE,E2 + UNTYPE,E1) / (UNTYPE,E1)$$

In this case, EEWS forces the term to go to zero and continues calculating the equation (in the example, the entire equation becomes zero). The researcher must insure that this result is appropriate (it is not in this example). The alternative is to tell the system maintainer or loader to have EEWS set the result of such a situation so that the user will see the words "ZERO DIVIDE" printed in the RESULTS report. (Remember that another equation which uses the result "ZERO DIVIDE" will force the term in question to zero--see note at the end of Section 3.4.)

(b) The equation requires an installation value and that value is zero; for example, the researcher wishes to calculate the inverse of the proportion of individuals in a given grade living off-post when they all live on-post:

$$\frac{(INSTL,E1,OFF,HOUSING + INSTL,E2,OFF,HOUSING + \text{ETC.})}{INSTL,E1,OFF,HOUSING}$$

Either this term will be set to zero or the equation will be set to ZERO DIVIDE; neither is desirable in some cases. In one instance, small constants were added to the numerator and denominator to protect against both situations.

4. The researcher is using the result of another equation which is either zero or a flagword value. Neither situation is unusual. If you use a term such as DESCRIPTOR,RES, check to see what happens when the value is 0--particularly when it is in the denominator. Again, the term will be set to zero unless you request that the entire output of the equation be set to "ZERO DIVIDE." In the second case, if a flagword (such as "ZERO DIVIDE") is the result of a previous equation and that result is used in an algebraic term, EEWS will force the term to go to zero. One way to avoid this situation is to set up a logical equation that first checks for strange possibilities and then, if none exist, does the algebraic calculations as shown in Figure 3-18.

```

IF
  ((INSTL, DESCRIPTOR, RES, TOPIC_AREA) EQ (0.0) OR
   (INSTL, DESCRIPTOR, RES, TOPIC_AREA) GE (1000000000000000) OR
   (INSTL, DESCRIPTOR, RES, TOPIC_AREA) LE (-1000000000000000) OR
   THEN -6000000000000000
   ELSE (52/(INSTL, DESCRIPTOR, RES, TOPIC_AREA))

```

This equation would calculate a result in units of: weeks per the type of activity under consideration (e.g. training) and will also prevent the calculation of:

```

52/(-1000000000000000)
(e.g.: 52/PRESENT)

```

Figure 3-18. Equation that protects against strange inputs.

4 TOPIC AREA PARAMETERS AND SYSTEM LIMITS

4.1 Topic Area Data

In addition to research dealing with individual equations, some points must be considered for the Topic Areas as a whole. These points must be investigated and the conclusions documented. They are:

1. Does the Topic Area use the results of equations from another Topic Area? If so, the researcher must tell the data loader which areas are the prerequisite areas. The data loader will input these areas. This procedure tells EEWS, "When a user requests Utilities Topic Area, you must first calculate the Housing equations to see how much of and where the utilities will be used."

2. If a zero division occurs, is the term to be set to the value zero or will the equation be set to MEANINGLESS? The answer applies to the entire Topic Area and cannot vary by equation.

3. For each value used from the INSTL files, if that value does not exist for an installation should:

(a) The value for NO DATA be put into the INSTL file?

(b) Zero be put into the INSTL file?

(c) Zero be put into the TYPICAL file?

(d) The average value of all available data be put into the TYPICAL file?

(e) The value for NO DATA be put into the TYPICAL file?

4. What are the summary ("plussed") equations (Chapter 5) for this Topic Area?

5. What are the components of the Unified Matrix for this Topic Area?

4.2 EEWS Limits for the Equation Writer

Limits have been set on the EEWS. Table 4-1 list those affecting the possible development of equations.

Table 4-1

Topic Area and EEWS Limits

Concern	Equation	Topic Area	EEWS
No. of descriptors	-	200	1000
No. of categories	-	250	250
No. of terms	202*	-	-
No. of operations	*	-	-
Total no. of terms and operations	200*	-	-
No. of characters-- descriptor short name	12	-	-
No. of characters-- descriptor full name	80	-	-
No. of characters-- category short name	12	-	-
No. of characters-- category full name	80	-	-
No. of characters-- Topic Area full name	32	-	-
No. of characters-- units of measure	4	-	-
No. of lines/note	63	-	-
No. of notes	-	-	1000
No. of characters/data source 80	-	-	-
No. of characters/installation short name	-	-	12
No. of characters/installation full name	-	-	48

*This is the limit after the first pass in EEWS equation evaluations. In the first pass, EEWS calculates all the values within and including the innermost parentheses.

5 THRESHOLDS AND SUMMARY REPORTS

5.1 Threshold Relationship to Equations and Summary Reports

Not all deficits are problems. Often, a critical limit must be passed before a deficit becomes large enough to cause a problem. For example, at an installation with 3000 units of bachelor housing suitable for enlisted persons, a deficit of 30 housing units as projected by the results of an equation is of little consequence. On the other hand, at a smaller installation with 100 rather than 3000 units, a deficit of 30 units is a major problem. To insure that the user is alerted to a problem in the second installation but not in the first, the "threshold" concept can be incorporated into EEWS equations.

A classical way of defining threshold is as the percentage of the current existing value (often that value stored in the INSTL column labeled EX) for a descriptor, above which it is unlikely that a real problem (i.e., one worth worrying about) will occur.

A researcher can develop equations that incorporate tolerances and that have different tolerances for each installation. To do this, the researcher can write a logic equation that does the test: "Is the new demand greater than x percent of the existing capacity?" The result will appear to the user as another descriptor in the RESULTS report.

This type of equation often is characterized as a summary of several important considerations within a Topic Area. For example, the demands of all the bachelor housing can be added together and tested to see if the new demand exceeds 10 percent of the existing capacity. If so, the output for such an equation should be a simple summary statement such as PROBLEM or NO PROBLEM.

Since many users will wish to see only a summarized EEWS report rather than a very detailed report, these types of summary or tolerance equations often are identified as those with which Army users are most likely to be concerned initially. To make them easy to identify, these equations all have descriptor names that begin with a plus sign (+) followed by up to 11 more characters.

Coordinated with "plussed" equations in EEWS are two higher order reports. The first is the SUM(mary) report. For a single Topic Area, for plussed descriptors only, it will automatically scan the RESULTS report and display the words "PROBLEM" or "NO PROBLEM" in SUM, usually after the plussed equation has carried out a threshold/tolerance test. Thus, the SUM report, which displays only the plussed descriptors for a single Topic Area, can contain from one descriptor to all descriptors--depending on what the researcher concludes a high-level user would be most interested in seeing.

The second report is the BRIEF summary. This BRIEF report scans the SUM report for every Topic Area; if, within a SUM report for a single Topic Area, any plussed descriptor indicates a problem (e.g., a negative number in the result such as -30000000000000 indicating PROBLEM), the BRIEF report will put the word "PROBLEM" at the intersection of that Topic Area row (only entire Topic Areas are considered) and the column for the installation under consideration. This tells the user that problem probably exists at the installation; the user should check the SUM and/or RESULTS report(s) for more information.

After using a tolerance test, it is possible, but not likely, that many or all descriptors will show deficits in the RESULTS report, but that no red flag will appear in

the BRIEF report because no deficits exceeded the calculated tolerance and so were not flagged in the SUM report. For the equation writer, these are important considerations because a headquarters-level user is likely to be concerned most often with the results of the BRIEF report, occasionally with the SUM report, and only now and then with the RESULTS report. RESULTS reports often are too detailed to convey the point of the problem to higher level planners (though the RESULTS report values are necessary to show how the problems occur). To provide for the BRIEF report, it is necessary to set up the plussed equations so that all will reflect a "bad" situation as resulting in a negative value. This procedure will make a flagword appear in the BRIEF and SUM reports, particularly if the tolerance limit has been passed. Flagwords with negative values as listed in section 3.3.4 were set up to reflect this consideration.

5.2 Thresholds for Plussed Descriptors

When the equation writer completes each plussed equation, he should ask himself, "Does this equation have a tolerable deficit?" If the answer is "no," then the tolerance value is zero. If the answer is "yes," a threshold value (in percent) should be assigned to the equation which should be written in logic form to test for the tolerance. Sometimes Army criteria suggest what this value should be. More often, the researcher needs to estimate what would be reasonable based on his best professional judgment.

6 GATHERING AND DOCUMENTING DATA

6.1 Gathering Data

EEWS is intended for use by Department of the Army (DA) and MACOM HQs. It is not intended that EEWS generate new surveys or questionnaires; instead, when possible, the researcher is expected to use data which are already collected and available from a central source (usually MACOM level or above). These data usually are in summary form when the MACOMs receive it; however, it is this level of detail that HQ planners normally use to make evaluations and judgments. EEWS's purpose is to support planners in their on-going duties, not to generate more work. Thus, the equation researcher usually is restricted to using central data sources such as those listed in Appendix A.

Data should be collected while the equations are being written in order to confirm their existence and availability. Data that may not be used for the equations should not be requested to avoid undue bother to the supplying agency. The researcher should expect a long lag between the time of requesting data and their receipt (usually a few months). Therefore, the researcher should plan work on several Topic Areas at once so that waiting for data will not delay progress in one area.

6.2 Documenting Data

Though the researcher may have in hand the data to support his equations, he still must put this information into a form understandable to the data loader. The data loader will need to know the names of the descriptors and their input order, the new categories, and how they relate to the TO&Es. The researcher should have already defined and documented this information as a UNIFIED TOPIC AREA MATRIX (Figure 3-3 in Chapter 3). Most data which the data loader will need to input are indicated on this form. In fact, to manually document the data appropriate for each installation, the researcher need only photocopy the Unified Matrix--one copy for each installation (plus TYPICAL)--and then fill in the darkened boxes with the values belonging to each installation.

Another way to translate data for inputting is to complete a form like the one shown in Figure 6-1. This form has several advantages:

1. It is coordinated exactly with the questions for which the data loader must provide answers.

2. It shows the note number next to the corresponding datum and its location.

3. A computer program is available which allows the researcher to input directly into the computer instead of transferring the data to the data loader for input. This feature also allows researchers and loaders to update data easily. In addition, the program will automatically format the data from this form into a stream input file which is acceptable to EEWS. Thus, EEWS receives data which the researcher inputs; there is no "go-between" where mistakes can occur. Complete information about this form will be documented in the *EEWS Data Input Manual*.

INSTL NAME: TEST		DATE 06/21/86		
FULL INSTL NAME: A TEST INSTALLATION		PAGE 01 OF 01		
TOPIC AREA: MEDICAL				
	DESCRIPTOR	CATEGORY	MULTIPLIER	NOTE #
1)	EX	1)TOT OFFICER	1) 1000	1) 13
1)	EX	1)TOT_ENLIST	1) 3000	1) 13
1)	EX	1)E1-4	1) 1000	1) 12
1)	EX	1)E5-6	1) 1000	1) 13

Figure 6-1. Example completed data input form.

6.3 Data Already in Magnetic (Computer-Readable) Form

The most desirable situation for obtaining data to support equations is to find a data source already stored on and accessible by a computer. In this case, support programmers can develop programs to access the other machine (or can read the magnetic tape or floppy disk) and format the data for automatic EEWS data input. The general process is outlined in the *EEWS Data Input Manual*. However, the researcher must confirm that the data are available, define the exact items desired, and document the source. It is usually possible to show that the equations work by simply obtaining and loading sample installations by manual methods. Whether or not the data are computer-readable, it is still the researcher's responsibility to insure that they are available to the loader.

6.4 TYPICAL Data

As explained in Section 3.2.3, when no data are found for an installation at the location:

(INSTL,DESCRIPTOR,CATEGORY,TOPIC_AREA),

EEWS will automatically seek out the same location in the TYPICAL file (rather than INSTL) and use the value stored at that location. Thus, the researcher must have a data file for the installation called TYPICAL in addition to all the other installations. Otherwise, when the equations are tested, a search of TYPICAL where values have not been stored by some method will cause the equation to fail and the result to be NO TYPICAL VALUE FOUND. Therefore, for every INSTL term to which a researcher refers in his equations, a TYPICAL value must be defined.

To inform the data loader what values are desired, use the same input forms described in section 6.2 (when data are to be "hard-wired") or indicate to the system maintainer (on the same form) that the average value is to be calculated and stored in TYPICAL.

Caution is needed when dealing with the TYPICAL file:

1. If the researcher does not load a value in INSTL, EEWS will go to TYPICAL for the value to be used. Loading a ZERO in INSTL will make EEWS calculate an expression using 0. Loading the value -1000000000000000 in INSTL will--

(a) In a logical equation, make the equation display NO DATA as the output (if the equation is set up to display a flagword) or,

(b) In an algebraic expression, make the equation stop calculating and display MEANINGLESS.

2. An equation writer can refer to TYPICAL for data--just as he can to any INSTL datum--using the form:

(TYPICAL,DESCRIPTOR,CATEGORY,TOPIC_AREA)

except when the CATEGORY is RES(ult).

3. A researcher often may wish to store a flagword in TYPICAL (e.g., NO DATA). This option is available and is a common usage of TYPICAL.

7 EQUATION TESTING AND FULL DOCUMENTATION FORMATS

7.1 Testing Loaded Equations

When the Equation Forms are written, values for a test installation are recorded and the equation is calculated using those data to produce a result. This procedure achieves three goals. First, it confirms that the data are available; second, it confirms that the equations work as expected; and third, it provides a value that can be compared to the one generated by the equation on the computer when finally loaded. This level of equation testing was described in detail in section 2.2.2. However, this is only a preliminary test. To fully test the equation, a MODEL session should be run. The following checks should be included (the best combinations of UNITYPE and installation inputs vary among Topic Areas):

1. Check an installation with complete, good data (as above).
2. Check TYPICAL to see what is stored there and how the system will react when a new installation is *added*.
3. Check an installation for which partial data are available to test the usage of your TYPICAL option.
4. Check an installation for which a zero divide will occur.
5. Check a UNITYPE input for which a zero input and a zero divide will occur if possible.
6. For cases in which you used data or results from another Topic Area, be sure to check what happens when the data value is zero and when the RESult you requested is a flag value (e.g., NO DATA, MEANINGLESS, or PRESENT).
7. Check to ensure that higher level reports (SUM and BRIEF) give correct responses.
8. Verify that the note numbers to which the system refers exist and are correct.
9. Verify that the units of measure exist and are correct.
10. Run an installation with subinstallations to ensure that the values shown in the subinstallations make sense and are correct.
11. Look at the results of the modeling runs to ensure the output values are reasonable (you *must* do this step).
12. Make sure you run the BRIEF report to confirm it is working correctly. The only outputs should be PROBLEM or NO PROBLEM. A possible output of NO DATA means that you have put no plussed equations in your Topic Area. This deficiency must be corrected.

Figures 7-1 and 7-2 show the test output for Endangered Species Topic Area RESULTS and SUM reports, respectively.

RESULTS - - ENDANGERED

DESCRIPTOR	UNIT	BLISS	BENNING
SENSITIVE?	FLAG	NO	YES
NOTE #_INSTL	NONE	227.00	NO DATA
NOTE_LEGEND	NONE	210.00	210.00
#END_SPECIES	EACH	28.00	NO DATA
SP1%RESTRIC	%	60.	0.
SP2%RESTRIC	%	62.78	0.
SP3%RESTRIC	%	51.67	0.
SP4%RESTRIC	%	41.25	0.
SP5%RESTRIC	%	41.25	0.
SP6%RESTRIC	%	69.72	0.
SP7%RESTRIC	%	56.53	0.
SP8%RESTRIC	%	71.11	0.
SP9%RESTRIC	%	54.44	0.
SP10%RESTRIC	%	49.58	0.
SP11%RESTRIC	%	55.83	0.
SP12%RESTRIC	%	54.44	0.
SP13%RESTRIC	%	48.19	0.
SP14%RESTRIC	%	71.81	0.
SP15%RESTRIC	%	67.64	0.
SP16%RESTRIC	%	53.75	0.
SP17%RESTRIC	%	49.58	0.
SP18%RESTRIC	%	50.97	0.
SP19%RESTRIC	%	46.81	0.
SP20%RESTRIC	%	38.47	0.
SP21%RESTRIC	%	41.25	0.
SP22%RESTRIC	%	42.64	0.
SP23%RESTRIC	%	53.33	0.
SP24%RESTRIC	%	46.11	0.
SP25%RESTRIC	%	46.11	0.
AV_%RESTRIC	%	53.04	NO DATA
ENDTRKIMPACT	FLAG	NO PROBLEM	PROBLEM
OTHEQPIIMPACT	FLAG	NO PROBLEM	PROBLEM
MNGMTBURDEN%	%	0.29	NO DATA
+BIG_IMPACT?	FLAG	NO	NO DATA
+ENDANG_DAM	FLAG	NO PROBLEM	PROBLEM

NOTE NO. 227

BLISS - (New Mexico Section) -----

ROC	HT	POC	Sea	#AC	PP	#ON	F	ST	RPot	Taxy	DThr	
SP1 = (Tularosa)ack-tailed prairie dog - Cynomys ludovicianus spp	4	1	4	6	1	1	3	-	E	H	1	2
SP2 = Black-footed ferret - Mustela nigripes	1	1	4	6	1	2	1	-	E	L	2	3
SP3 = Desert bighorn sheep-- Ovis canadensis mexicana	1	3	2	6	1	1	1	-	E	L	2	2
Mississippi kite Ictinia mississippiensis	2	1	4	1	1	1	1	-	E	L	2	1
SP5 = Black hawk - Buteogallus anthracinus anthracinus	2	1	4	1	1	1	1	-	E	L	2	1
etc...												

Figure 7-1. RESULTS report for the Endangered Species Topic Area.

SUMMARY - ENDANGERED		
DESCRIPTOR	BLISS	BENNING
+BIG_IMPACT?	NO	NO DATA
+ENDANG_DAM	NO PROBLEM	PROBLEM

Figure 7-2. Summary report for the Endangered Species Topic Area.

7.2 Final Documentation

When equations are completely written and the Topic Area is finished, the documentation must be completed and organized. Standards have been established for this process as suggested at the end of section 2.2.1. The documentation can be divided into two parts based on the intended reader: the general user or the detailed reviewer.

7.2.1 Briefing Notes

When a beginner uses EEWS, after trying to understand what the descriptors mean (as available during an EEWS session in the TRANS(lation) report), he will wish to have a brief description of how the Topic Area was generated. The new user is likely to be looking over the Topic Areas for the first time to see what might be useful to him. The Briefing Notes serve this function. They consist of:

1. A one-page general description of the Topic Area concept (Figure 7-3 is a blank form and Figure 7-4 is a completed form).
2. The list of input categories used in the equations (Figure 7-5).
3. The list of descriptors and their full names for reference outside an EEWS session (Figure 7-6).

The initial set* of EEWS documents generated using this procedure is presented in the *EEWS Topic Area Brief Documentation*.

*Those delivered to FORSCOM in August 1985.

EEWS TOPIC AREA BRIEFING SHEET

TOPIC AREA:

1. DEFINITION OF TOPIC AREA:

2. MAJOR OUTPUT TYPES:

3. MAJOR INPUT DATA SOURCES:		UPDATE	UPDATE	MOST
		FREQUENCY	METHOD	RECENT
3a	INPUT CATEGORY DATA:			DATA
3b	INSTALLATION DATA:			

4. TOPIC AREA DESIGN (TOPIC AREA FLOW CHART):

5. SUMMARY (PLUSSED) EQUATIONS AND THEIR MEANING:

ATTACHMENTS:

- ... INPUT CATEGORY ABBREVIATIONS AND FULL NAMES
- ... OUTPUT DESCRIPTOR ABBREVIATIONS AND FULL NAMES

Figure 7-3. Brief Topic Area concept description--blank form.

EEWS TOPIC AREA BRIEFING SHEET

TOPIC AREA: HOUSING

1. DEFINITION OF TOPIC AREA:

Housing deals with three major questions: family housing (in family housing units, e.g. apartments or detached structures), bachelor housing units (by places available/individual e.g. a bed in a double room), and net and total moves of military personnel on and off the installation. Housing is used as an input to other topic areas to calculate demands which have more directly environmental impacts per Figure 2.1.

2. MAJOR OUTPUT TYPES:

Surplus Number of units of family housing of x bedrooms for different grades.
Surplus Number of units of bachelor housing for different grades
Net changes of military personnel on and off the installation.

3. MAJOR INPUT DATA SOURCES:

UPDATE : UPDATE : MOST

FREQUENCY : METHOD : RECENT

3a INPUT CATEGORY DATA:

DATA

TOWEs, recapitulation of personnel by grade: 6 months: comput: current:

3b INSTALLATION DATA:

DD Form 1377 & 1378 / Family Housing

: Yearly : Comput: current:

DD Form 1657 / Bachelor Housing

: Yearly : Comput: current:

4. TOPIC AREA DESIGN (TOPIC AREA FLOW CHART):

For housing:

New Surplus = Current Surplus in housing type currently at the installation minus the value:

% which goes on (or off) of the installation)

times (New Demand for housing/person for grades considered)

times (The proportion of those individuals which go into this type CONUS wide)

For net moves:

As above but without subtracting the value from the Current Surplus

5. SUMMARY (PLUSSED) EQUATIONS AND THEIR MEANING:

Problem/No Problem for the demand by grade and locations summed

for: Family housing on/off installation (enlisted or officers);

Bachelor housing on/off installation (enlisted or officers); and

recruit housing.

ATTACHMENTS:

29 INPUT CATEGORY ABBREVIATIONS AND FULL NAMES

145 OUTPUT DESCRIPTOR ABBREVIATIONS AND FULL NAMES

Figure 7-4. Example completed brief concept description for Housing Topic Area.

ENLISTED GRADE ABBREVIATIONS

1. CATEGORY

1. E1
ENLISTED OF GRADE 1 (RECRUIT)

2. TOT OFFICER
TOTAL NUMBER OF OFFICERS

3. E2
ENLISTED OF GRADE 2

4. E5-6
ENLISTED OF GRADE 5-6

5. E3
ENLISTED OF GRADE 3

6. E7-9
ENLISTED OF GRADE 7-9

7. E4
ENLISTED OF GRADE 4

8. O1-2
OFFICERS OF GRADE 1-2

9. E5
ENLISTED OF GRADE 5

10. O3-10
OFFICERS OF GRADE 3-10

11. E6
ENLISTED OF GRADE 6

12. E7
ENLISTED OF GRADE 7

14. E1-4
ENLISTED OF GRADE 1-4

Figure 7-5. Input categories used.

TOPIC AREA DESCRIPTION

TOPIC NAME = HOUSING

- 1 TEMP_PMAR
PERCENT MARRIED
MILITARY MARKET FACTS BOOK, 1974
UNITS OF MEASURE= UNIT
 - 2 E131BROF
ENLISTED OF GRADE 1 TO 3 IN 1 OR 2 BDRM HSING, OFF POST, MARRIED
DD 1378
UNITS OF MEASURE= UNIT
 - 3 E133BROF
ENLISTED OF GRADE 1 TO 3 IN 3 BDRM HSING, OFF POST, MARRIED
DD 1378
UNITS OF MEASURE= UNIT
 - 4 E134BROF
ENLISTED OF GRADE 1 TO 3 IN 4 BDRM HSING, OFF POST, MARRIED
DD 1378
UNITS OF MEASURE= UNIT
 - 5 E461BROF
ENLISTED OF GRADE 4 TO 6 IN 1 TO 2 BDRM HSING, OFF POST, MARRIED
DD 1378
UNITS OF MEASURE= UNIT
 - 6 E463BROF
ENLISTED OF GRADE 4 TO 6 IN 3 BDRM HSING, OFF POST, MARRIED
DD 1378
UNITS OF MEASURE= UNIT
 - 7 E464BROF
ENLISTED OF GRADE 4 TO 6 IN 4 BDRM HSING, OFF POST, MARRIED
DD 1378
UNITS OF MEASURE= UNIT
 - 8 E791BROF
ENLISTED OF GRADE 7 TO 9 IN 1 TO 2 BDRM HSING, OFF POST, MARRIED
DD 1378
UNITS OF MEASURE= UNIT
 - 9 E793BROF
ENLISTED OF GRADE 7 TO 9 IN 3 BDRM HSING, OFFPOST, MARRIED
DD 1378
UNITS OF MEASURE= UNIT
- etc..

Figure 7-6. DESCRIPTOR full names.

7.2.2 Detailed Documentation

When a user begins to question in detail how EEWS derived its answers, he will look at the full documentation. This user is likely to be another researcher trying to determine if some of your outputs would be good input for his equations. This user/researcher will probably have a good understanding of EEWS and will be critically evaluating the reasoning and correctness of your work. Thus, the documentation must be complete but concise. Figure 7-7 shows the format for full documentation. The initial set of EEWS documents generated using this procedure is presented in the *EEWS Topic Area Brief Documentation*.

I. INTRODUCTION:

A synopsis of Topic Area objectives (i.e., what does this Topic Area seek to measure?)

II. OUTPUTS:

Explanations of:

- (a) how Army actions (and simulated user moves) affect Topic Area subject matter and outputs (step 7, Figure 2.1);
- (b) the use of plussed equation outputs (step 19, Figure 2.1);
- (c) major Topic Area outputs

III. LOGIC:

Brief discussion of Topic Area organization and logical structure, with appended Topic Area flow chart (step 9, Figure 2.1);
Notations made within this section and flow chart, of whether and where results generated by another Topic Area were used here (steps 5 and 11, Figure 2.1)

IV. METHODOLOGY:

Part I: Topic Area background research done and alternative methodologies examined

- (a) background research done (step 6, Figure 2.1);
- (b) discussion of Army criteria and requirements relevant to Topic Area (step 8, Figure 2.1);
- (c) discussion of Topic Area methodology used;
- (d) description, and reasoning behind rejection, of alternative Topic Area methodologies considered (step 6, Figure 2.1)

Part II: Explanation of Topic Area equations and outputs, including the

- (a) detailed exposition of each equation (or each group of analogous equations) (step 20a, Figure 2.1);
- (b) explanation of the use of TYPICAL values, and their determination (step 20b, Figure 2.1)

V. Section 4:

Discussion of data quality and sources (steps 12 and 13, Figure 2.1)

- (a) The nature and form of data used:
 - 1. Types, Forms, and Sources of Topic Area data used;
 - 2. Topic Area data Quality, Consistency, and Reliability of collection;
 - 3. Methods and Frequencies of Topic Area data generation
- (b) Other data sources examined, and the reasoning behind the rejection of such sources
- (c) Data impact on Topic Area methodology and outputs:
 - 1. how the nature and availability of data influenced final Topic Area structure and outputs;
 - 2. a comparison of desired Topic Area structure and outputs with those used;
 - 3. a notation of whether data quality, forms, and sources are expected to change in the foreseeable future
- (d) Updating of Topic Area data:
 - 1. the frequency with which Topic Area data is expected to be updated;
 - 2. the method by which Topic Area data is to be updated;
 - 3. data sources to be used for the future collection of Topic Area data

VI. Original Equation Forms (steps 15, 16, 18, Figure 2.1)

VII. Copy of current EEWS Topic Area equations (step 21, Figure 2.1)

VIII. Example Topic Area outputs, using Test installations (step 31, Figure 2.1)

Figure 7-7. Format for full documentation.

8 CONCLUSION

EEWS is a computer system that predicts possible environmental effects of proposed or contemplated mission changes or troop and equipment realignments. These predictions are specific for each of the major CONUS installations included in the system and are made during an EEWS interactive session based on the user's inputs. To enable the system to handle many types of potential environmental effects, it must be programmed to make specific predictions about the different areas of concern. These predictions are made via equations.

Equations are formatted and documented in a way that facilitates their entry into the computer on which EEWS resides by a nontechnical data/equation loader. The EEWS equations are the central means of driving the demand and impact evaluations presented as output to a user during an interactive EEWS session.

This report has explained in detail how a researcher with a professional background in an area of environmental concern formats and documents equation development and gathers the supporting data. Covered in detail were the step-by-step process of researching a Topic Area, the way to translate that research into a form acceptable to EEWS, and the method of documenting equations and supporting data.

This report is one in a series that fully documents the establishment and maintenance of EEWS. The material is intended to be used by the ultimate Assigned Responsible Agency (ARA) for EEWS to generate new areas of predictive environmental modeling or by contractors assigned to that task by the ARA.

APPENDIX A: DATA AND CRITERIA BASIC SOURCES

A-1. CRITERIA SOURCES FOR ARMY USE STANDARDS

a. Official Army and DOD Documents

Army Regulation (AR) 415-28, *Department of Army Facility Classes and Construction*. Includes other documents for each facility category which may be useful in developing impact algorithms for that class.

Technical Manual (TM) 5-800-1, *Construction Criteria for Army Facilities*. Covers many facilities not directly connected with execution of the installation's mission. Sports, social, and human support facilities are discussed.

TM 5-803-1, *Installations Master Planning Principles and Procedures*.

DOD 4270.1-M, *Construction Criteria Manual*. Similar to TM 5-800-1, but more detailed.

AR 210-21, *Installation's Training Areas and Facilities for Ground Troops*. An aid in determining training area needs.

Emergency Expansion Capability Master Plans. Required through AR 210-23 (*Installation Emergency Capabilities*). Some approaches to calculating utility impacts may be used as models in developing similar EEWS algorithms.

Training Circular (TC) 25-1, *Training Lands*, and TC 25-2, *Training Ranges*. Both are useful in developing range impact algorithms.

AR 415-28, *Department of the Army Facility Classes and Construction Categories*. Defines the Army category codes associated with each facility type. These codes will be used in EEWS where appropriate. They also have related data in many other sources.

AR 415-31, *Basic Facilities and Space Allowances*. Covers several facility categories not considered in the updated documents. However, these standards are no longer official. A disclaimer must be attached to the final equations stating that, in many cases, the algorithms used are only approximate and do not necessarily identify the facility needs precisely.

AR 415-50, *Basic Facilities and Space Criteria for Construction at United States Installations in Event of Emergency*. Covers the publications of facilities not officially evaluated in any other publication.

b. Information Compiled for the Army

1. Robert G. Muir and Associates of Colorado Springs, CO, under a contract through the Fort Worth District, conducted a thorough study of the existing documentation and generated the *Army Facility Requirements* in two documents; each contains information organized by the construction category codes set out in AR 415-28. Appendix A (of the Muir report), lists applicable documentation by three- and four-digit codes. The Muir report includes the applicable references for each particular

category and reproduces salient information contained in the references. (To obtain a copy, contact the U.S. Army Corps of Engineers, Fort Worth District, P.O. Box 17300, Fort Worth, TX 76102-0300.

2. *Table of References for Authorized Space.* This document was compiled by the Facility Systems Division of USA-CERL. It mainly considers codes at the three-digit level, denoting the documentation dealing with each category.

**A-2. DATA INFORMATION SOURCES FOR CURRENTLY EXISTING
AND CURRENT SURPLUS INFORMATION**

NAME OF DATA BASE IFS (I) Integrated Facilities System

TYPE OF INFORMATION All facilities-specific information for all Army installations

PROPONENT AGENCY DAEN-RE

DATE OF INITIAL DEV. Early 1980s

UPDATE INFO. Much info to be updated
quarterly

AVAILABLE FROM:

Information passes from the indiv.
installations BASOPS to FESA-FS-SD
to a contractor and EDPC.

AVAILABLE TO:

Army facilities planners

FORMAT INFORMATION & ATTACHED SOFTWARE

DETAIL/RESOLUTION (levels of detail, resolution, categories, category definitions,
compatibility with other systems)

Very detailed information is to be included in the Data Base concerning individual
structures.

Some pieces of information useful to EEWS:

Total # of buildings and sq. ft. of area in each facility code.
Information about current use as well as suggested use.

History and future of the information (why developed, for whom, what is planned for the
future, etc.)

Is to support the data requirements of:

AR 405-45, *Inventory of Army Real Property*
AR 420-17, *Real Property and Resource Management*
AR 210-20, *Installation Master Planning*
DA Pam 420-6, *Resource Management*

NAME OF DATA BASE Emergency Expansion Capability Master Plans

TYPE OF INFORMATION Installation Generated Reports (AR 210-23)

PROPONENT AGENCY _____

DATE OF INITIAL DEV. Early 1970s

UPDATE INFO. _____

AVAILABLE FROM:

Individual installations

AVAILABLE TO:

Army planners

FORMAT INFORMATION & ATTACHED SOFTWARE

All paper reports. No computerized data bases as yet.

DETAIL/RESOLUTION (levels of detail, resolution, categories, category definitions, compatibility with other systems)

- Steps:
- 1 Utility Analysis
 - 2 Operational Facility Analysis
 - 3 Summary of Utility and Operational Conditions that Limit Exp. Cap.
 - 4 Cantonment Analysis
 - 5 Maximum Capability Plan
 - 6 Environmental Analysis

History and future of the information (why developed, for whom, what is planned for the future, etc.)

Developed to provide Army planners with installation capability information.

The information is to be updated yearly.

NAME OF DATA BASE Analysis of Existing Facilities/Environmental Assessment Report

TYPE OF INFORMATION as title / paper reports. 1 per installation

PROPONENT AGENCY (AR 210-20)

DATE OF INITIAL DEV. Early 1970s

UPDATE INFO. To be updated yearly

AVAILABLE FROM:

AVAILABLE TO:

Individual installations

Army planners

FORMAT INFORMATION & ATTACHED SOFTWARE

Paper report only. One report per installation. Each installation is responsible for its own report, although in most all cases, outside consulting firms compile the reports information.

Each report is to follow a *predescribed outline as present in AR 210-20.*

DETAIL/RESOLUTION (levels of detail, resolution, categories, category definitions, compatibility with other systems)

Complete verbal description supported by maps of the installation's environmental setting, land use relationships and transportation and utility systems.

History and future of the information (why developed, for whom, what is planned for the future, etc.)

The information is intended to be the central source of installation physical data. It is intended to be kept updated, though it is not clear that these reports are being updated yet.

The USA-CERL library is attempting to collect these reports from all installations.

NAME OF DATA BASE Military Markets Facts Book

TYPE OF INFORMATION Facts important in doing military market analyses

PROPONENT AGENCY _____

DATE OF INITIAL DEV. 1973/1974

UPDATE INFO. Every few years

AVAILABLE FROM:

AVAILABLE TO:

Army Time Publishing Company

Anyone

FORMAT INFORMATION & ATTACHED SOFTWARE

400 pp.

Part 1 The Customer Pool

Incl. base-by-base analysis of mil. pop.

Part 2 The Resale System

DETAIL/RESOLUTION (levels of detail, resolution, categories, category definitions, compatibility with other systems)

Deployment of Dependents

Family/Dependent Data

Retired Information

History and future of the information (why developed, for whom, what is planned for the future, etc.)

Developed for all interested in the military market situation. Enables the adequate analysis of how to better serve the military market.

NAME OF DATA BASE Domestic Base Factors Report

TYPE OF INFORMATION Pater Report, includes all military installations

PROPONENT AGENCY Office of the Assistant Secretary of Defense Manpower Reserve Affairs and Logistics (Department of Defense)

DATE OF INITIAL DEV. _____ UPDATE INFO. Yearly

AVAILABLE FROM: _____ AVAILABLE TO: _____

Office of the Assistant Secretary
of Defense Manpower, Reserve
Affairs and Logistics.

FORMAT INFORMATION & ATTACHED SOFTWARE

Coded tabular information. Not known if CCT tapes are available.

DETAIL/RESOLUTION (levels of detail, resolution, categories, category definitions, compatibility with other systems)

Installation Population Data	Installation Training Activity Data
Total pop.	Student ADL
Avg. equiv. daily Reserve comp.	Number of buildings used for training and other sq. ft.
Aviation	
Other	
Avg. daily load of students	
Mission pop.	Mission Data
Dependent pop.	Total number of battalions/squadrons
Management Indicators	Number of combat type unit equip.
MILCON, FYDP information	Total number of divisions/wings
	Total number of brigades/groups
	Total number of battalions/squadrons
	Etc.

History and future of the information (why developed, for whom, what is planned for the future, etc.)

General overview information for all installations. Assumed to be available in future.

NAME OF DATA BASE HOMS (Housing Operations Management System)

TYPE OF INFORMATION Computer system for operation in FY 82 or later.

PROPONENT AGENCY DAEN-ZCH-S

DATE OF INITIAL DEV. FY 82

UPDATE INFO. _____

AVAILABLE FROM: _____

AVAILABLE TO: _____

Installation planners

FORMAT INFORMATION & ATTACHED SOFTWARE

DETAIL/RESOLUTION (levels of detail, resolution, categories, category definitions, compatibility with other systems)

HOMS is a comprehensive housing management system which will standardize and automate housing operations. Family, bachelor, and transient housing are covered. Will aid budgeting, master planning, operations, maintenance and repair, and assets accounting.

History and future of the information (why developed, for whom, what is planned for the future, etc.)

See explanation under DETAIL/RESOLUTION above.

NAME OF DATA BASE TAB (Tabulation of Existing and Required Facilities)

TYPE OF INFORMATION Currently, installation-generated reports

PROPONENT AGENCY (AR 210-20)

DATE OF INITIAL DEV. _____

UPDATE INFO. Updated Yearly

AVAILABLE FROM:

AVAILABLE TO:

Produced by individual installations

Army planners

FORMAT INFORMATION & ATTACHED SOFTWARE

Facility space (allowed, required, and existing) is tabulated by facility category codes. All information is based on the FYDP as revealed through ASIP information.

DETAIL/RESOLUTION (levels of detail, resolution, categories, category definitions, compatibility with other systems)

Information is disaggregated to the facility classification codes as defined in AR 415-28.

History and future of the information (why developed, for whom, what is planned for the future, etc.)

Existing facility information for the TAB is developed from IFS (I) type information. That is, the TAB is not an original source of facility information.

NAME OF DATA BASE SIDPERS (Standard Installation/Division Personnel System)

TYPE OF INFORMATION Installation/Division Personnel

PROPONENT AGENCY HQDA

DATE OF INITIAL DEV. _____

UPDATE INFO. Continuously

AVAILABLE FROM: _____

AVAILABLE TO: _____

SIPERS Interface Branch (SIB) or
MILPO-Military Personnel Office

FORMAT INFORMATION & ATTACHED SOFTWARE

Provided through

- a. Recurring reports
- b. Inquiries
- c. SIDPERS information retriever

DETAIL/RESOLUTION (levels of detail, resolution, categories, category definitions, compatibility with other systems)

Personnel data supported at the division, installation, brigade, battalion and unit levels.

To service active Army personnel and other special component personnel (not civilian) and service or foreign military. Active reserves, inductees, AWOLs replacements.

Interfaces

Officer Master File (OMF) 2nd Enlisted Master File (EMF) maintained at HQDA (milpercen)
Centralized Assignment Procedures III System CAP III
Military Occupational Specialty Edit File (SMEF)
Central Transient Accounting System (CRTI)
Unit Identification System/FORSTAT
Vertical Army Authorization Document System (VTAADS)
Theater Army Roll-up (TAPER) Systems
Reception Station System

History and future of the information (why developed, for whom, what is planned for the future, etc.)

Reports(s)

Authorized Strength Inquiry Report

To provide information maintained on the SIDPERS Author Str. File (SASF) based on the TOE, MTOW, or TOA Authorization Documents

Personnel Strength Zero Balance Report

APPENDIX B: TABLES OF ORGANIZATION AND EQUIPMENT (TO&E) PRIMER

To gather the TO&Es (Tables of Organization and Equipment) information for EEWS equation inputs, it is first necessary to identify a list of personnel and equipment related to Army units which is required by the EEWS equations. This list usually is developed by referring to the TO&Es. They list all personnel and nonconsumable equipment assigned to a theoretical unit of a particular standard type (e.g., what comprises an average tank battalion). TO&Es have examples of all authorized Army unit types and are identified by SRC numbers. A summary of all major unit TO&E numbers and equipment categories (with their codes) is in Field Manual (FM) 101-10-1.1⁴ (Example B-1). This Field Manual is relatively standard and comprehensive, and covers most basic units that EEWS might need to access. In the TO&Es, a detailed list of the number of personnel within each grade (E1 to O10) assigned to each unit is also stored⁵ (See Figure 3-3 in Chapter 3). From these TO&Es, EEWS can access a complete listing of the personnel and equipment assigned to each unit or, more commonly, groupings of personnel or equipment can be assigned to an EEWS category.

To use this information as input for the terms in an EEWS equation, the researcher must understand the TO&Es, establish what each of their columns in them stands for, and explain their relevance to EEWS needs. The line/LIN column gives the equipment code in alphabetical and numerical order (e.g., A11538, BOO326, CO1454 as in Example B-1).

The Equipment Readiness Code (ERC) column is divided into three categories: A, B, and C. Category A contains all the equipment currently used by the unit. Categories B and C are for support of equipment under category A. For example, say a unit has been assigned 50 four-by-four trucks, of which, only 35 are essential to the unit's mission. These 35 trucks are placed in category A, and the remaining 15 in category B. A category B truck is used when a category A truck is to be fixed. The same happens with equipment divided into B and C. For EEWS purposes, the total amount of equipment assigned to the unit (A + B + C) usually is desired because EEWS assumes the worst case in order to suggest to planners the worst possible result when personnel are moved from one installation to another. For example, in category L44595, A = 35 and B = 75, so A + B = 110. Thus, 110 is the usual amount of equipment assumed to be moved.

The amount of each type of equipment assigned to each unit is located under the heading "Strength Levels." There are three different levels: SL1, SL2, and SL3. Equipment categorized as SL1 is that required for 100 percent readiness for combat; SL2 has 90 percent of this issue and SL3 has less than 80 percent. For EEWS, a researcher normally considers only the equipment listed under SL3 because this is typical of the peacetime mission assumed by the system.

⁴FM 101-10-1.1, *Staff Officers' Field Manual—Organizational Technical and Logistic Data* (Headquarters, Department of the Army, July 1976).

⁵*Tables of Organization and Equipment* (Headquarters, Department of the Army, 1 April 1983).

Table 2-1 Summary of Equipment Type of Armored Division (with Mobile Assault Bridge)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I	LIN	Nomenclature	HHC (174H)	AMP (192H)	CBT (3019H)	Div (1787H)	Sig (1135H)	Eng (15145H)	Three Bde HHC (1742H)	Arm'd (17105H)	DISCOM (2921H)	ADA (44325H)	Six tank bn (1735H)	Five inf bn (1745H)	Div (17H)
		Class IIA—Air													
2	AZ383	Aerial recovery kits for Army aircraft	0	0	0	0	0	0	0	0	0	0	0	0	2
3	M02470	Maint platform hyd adj to 10 ft high, 44 in wide	0	0	0	1	0	0	0	3	0	0	0	0	4
4	M02504	Maint platform hyd adj type 3 to 7 ft high	0	0	0	1	0	0	1	3	0	0	0	0	9
		Class IIB—Troop Support													
5	K39714	Hoisting unit for mountings, organizational maint set no 7	0	1	0	0	0	0	0	0	1	0	0	0	3
6	L64542	Lt vlt op area acct, 1 kw, heliport (Army)	0	0	0	1	0	0	0	1	1	0	0	0	4
7	P92040	Pump, centrif, gas driven, frame mtd, 2 in, 125 GPM 50 ft hd	0	0	0	0	0	5	0	0	0	0	0	0	5
8	T10600	Shop equip, guided missile, aux equip maint (Chaparral)	0	0	0	0	0	0	0	0	0	2	0	0	2
9	V84014	Test set, radar, AN/TPM 23 (VADS)	0	0	0	0	0	0	0	0	0	2	0	0	2
10	W32867	Shop equip, auto maint and repair, org sup no 1, less power	1	1	1	1	0	1	1	1	8	5	3	4	61
11	W67843	Torch outfit, cutting and welding, set 2	0	0	0	0	0	4	0	0	0	0	0	0	4
12	Z13157	Card punch mach and ADPE	0	0	0	0	0	0	0	0	0	0	0	0	7
13	Z74660	Sorter, ADPE	0	0	0	0	0	0	0	0	0	0	0	0	2
14	F77651	CS3, Data Analysis Central, OL 88(V), 1 MYK 8(V)	0	0	0	0	0	0	0	0	1	0	0	0	1
15	F77918	CS3, Data Storage Group, OL 89(V), 1 MYK 8(V)	0	0	0	0	0	0	0	0	1	0	0	0	1
16	F77964	CS3, Data Support Facility Mobile, V 460 MYK 8(V)	0	0	0	0	0	0	0	0	1	0	0	0	1
17	M57481	CS3, Maintenance Shop Facility, Mobile V 452, MYK 8(V)	0	0	0	0	0	0	0	0	1	0	0	0	1
18	U43735	CS3, Storage Facility, Mobile, V 483/MYK 8(V)	0	0	0	0	0	0	0	0	1	0	0	0	1
19	J35801	CS3, Generator, Diesel Engine, 100 kw, 60 hz, mounted on M353, PU 495	0	0	0	0	0	0	0	0	2	0	0	0	2
20	X59326	CS3, truck tractor, 5 ton, 6x6 w/e, M818	0	0	0	0	0	0	0	0	2	0	0	0	2
		Class IIE—General Supply													
21	G68966	Drum, fabric, collapsible, liquid fuel 500 gal capacity	0	0	0	6	0	0	0	6	0	0	0	0	39
		Class IIG—Electronics													
22	G68719	Cable telephone, WO 1-TT OR 8132U/H	0	3	64	12	61	32	4	139	28	320	118	114	2,398
23	G68856	Cable telephone, WO 1-TT RL 159U, 5,280 ft	0	3	0	4	109	23	40	0	415	24	2	6	771
24	G68953	Cable telephone, WO 1-TT 2 cond, fld wire	0	0	0	0	0	23	20	20	0	0	0	42	471
25	R30662	Receiver-transmitter, con go, AN/CRA 6	0	0	0	1	0	0	1	1	0	5	0	0	12
26	U82529	Switchboard telephone manual and SB 993/GT	0	0	0	0	0	12	0	0	8	12	4	6	88
27	V30937	Telephone, TA 264/PT	0	0	0	0	0	0	0	2	5	0	0	0	14
		Class IIW—Ground													
28	C29490	Bucket, clamshell, 1/2 cu yd	0	0	0	0	0	2	0	0	0	0	0	0	2
29	C30997	Bucket, dragline, 1/2 cu yd	0	0	0	0	0	1	0	0	0	0	0	0	1
		Class VIIA—Air													
30	K29660	Helicopter, attack, AH 1G	0	0	0	0	0	0	0	9	0	0	0	0	9
31	K31042	Helicopter, observation, OH 58A	0	0	0	6	0	0	4	10	0	0	0	0	42
32	K31795	Helicopter, utility, UH 1H	0	0	0	4	0	0	0	8	1	0	0	0	13
33	T17093	Shop set, acct maint, ambt & UH 1/OH 6, co size, DS	0	0	0	0	0	0	0	1	0	0	0	0	1
34	W62611	Tool set, avn unit maint set no 1, ambt	0	0	0	1	0	0	1	3	2	0	0	0	9

EXAMPLE B-1

Table 2-1 Summary of Equipment Type of Armored Division (with Mobile Assault Bridge) (Continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
LIN	Nomenclature	HHC (1744)	MP L (1927H)	CBT/L (3019H)	Div adv L (1787H)	Sig bn (1135H)	Eng bn (5155H)	Three bde HHC (1742H)	Armd adv bn (1710H)	D+adv (6300H)	DISCOM (2921H)	ADA bn (48125H)	Six bn (1735H)	Five bn (1745H)	D+ Total (174H)
35 W93995	Trailer, act maint ambli 4 wheeled 30.48 in tritail system	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36 X23227	Transporter, ambli, hyd lift for shelter and X-4 container	0	0	0	0	0	0	0	3	1	0	0	0	0	1
Class VIII - Troop Support															
37 C25757	Bridge, floating, raft, sec light tactical	0	0	0	0	0	2	0	0	0	0	0	0	0	2
38 E67735	Compressor, RCP, power drive, base AC 115V 60 cycle 1 ph 1.5 CFM 50 PSI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39 E65242	Compressor, RCP, power drive, air rec, gas drive 15 CFM 175 PSI	0	0	0	0	0	1	0	1	5	5	0	1	1	34
40 E70064	Compressor, RCP, power drive, 2 wheeled, 1000 psi, gas drive, 5 CFM 175 PSI	1	1	1	1	1	5	1	5	24	1	1	1	1	111
41 E70201	Compressor, RCP, power drive, 2 wheeled, 1000 psi, gas drive, 8 CFM 175 PSI	0	0	0	0	0	0	1	1	1	0	0	0	0	6
42 E70817	Compressor, RCP, power drive, air wheel, gas drive 4 CFM 3000 PSI	0	0	0	0	0	0	0	0	0	1	0	0	0	1
43 E73676	Compressor, rotary, power drive, air wheel, frame 2 pneu tires, gas drive, 60 CFM 6.5 PSI	0	0	0	0	0	2	0	0	0	3	0	0	0	5
44 G02204	Detecting set, mine, dtbl, metallic and nonmetallic	0	4	1	0	0	7	0	10	25	6	5	5	1	162
45 G07341	Detecting set, mine, dtbl, metallic (AN/PSS 11)	0	4	1	0	0	13	0	10	25	6	5	5	2	158
46 G32473	Diving equip set, 1 person, scuba, open circuit	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47 H38757	Ferry conversion set, raft, inf spr	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48 H94824	Fwd area refueling equip (FARE)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49 J04716	Fuel sys sup pt, dtbl 60,000 gal cap	0	0	0	0	0	0	0	2	0	4	0	0	0	4
50 J35492	Generator set, dsl eng, 15 kw, 60 hz, mid on M200, PU 405	0	0	0	0	0	1	0	0	0	1	0	0	0	1
51 J35679	Generator set, dsl eng, 15 kw, 60 hz, mid on M200, PU 650	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52 J35835	Generator set, dsl eng, 15 kw, 60 hz, 3 ph AC 120/208 240/416V, skid, tac, util	2	0	0	0	0	0	0	0	0	2	0	0	0	4
53 J36109	Generator set, dsl eng, 30 kw, 60 hz, 3 ph AC 120/208 240/416V, 50 hz, tac, util	0	0	0	0	0	0	0	0	0	1	0	0	0	1
54 J36383	Generator set, dsl eng, 30 kw, 60 hz, mid on M200, PU 406	0	0	0	0	0	0	0	0	0	2	0	0	0	2
55 J36725	Generator set, dsl eng, 30 kw, AC 120/208 240/416V 3 ph, 400 hz tac, discrip	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56 J38301	Generator set, dsl eng, 60 kw, 60 hz, 3 ph AC 120/208 240/416V, 50 hz, tac, util	0	0	0	0	0	0	0	0	0	4	0	0	0	4
57 J41041	Generator set, gas eng, 100 hp, PU 253/U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58 J41452	Generator set, gas eng, 100 hp, PU 253/U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59 J42100	Generator set, gas eng, 100 hp, PU 253/U	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60 J42685	Generator set, gas eng, 0.3 kw, AC 115V 1 ph 400 hz, DC 24 to 35V	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61 J42856	Generator set, gas eng, 0.5 kw, 28V, skid, shock, tac, util	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62 J42976	Generator set, gas eng, 0.5 kw, 60 cycle 1 ph AC 120 240V, shock, mid	0	0	0	0	0	0	0	0	0	1	0	0	0	1

EXAMPLE B-1 (Cont'd)

**APPENDIX C:
OFFICIAL ARMY UNITS OF MEASURE**

Symbol	Unit of Measure
AC	Acres
BD	Hospital Beds, Normal Capacity
BL	Barrels, Capacity
BX	Boxes
CF	Cubic Feet
EA	Each
FA	Family Unit
BF	Feet of Berthing
GA	Galloons, Capacity
GM	Gallons Per Minute, Capacity
KG	Thousand Gallons Per Day, Capacity
KV	Kilovolt-Amperes, Capacity (KAV)
KW	Kilowatt, Capacity
LF	Linear Feet
MB	Million British Thermal Units Per Hour, Capacity
MI	Miles, Statute
MN	Persons, Designed Capacity
OL	Outlets, Number of
OU	Operating Units
SE	Seats
SF	Square Feet
STTN	Standard Ton
SY	Square Yards
TN	Tons, Capacity
VE	Vehicles

The units of measure of "SF" will be the primary unit of measure for all buildings. Other units of measure will apply to facilities other than buildings and to buildings such as hospitals, dormitories, etc., when the designed capacity must also be described (e.g., beds, men, etc.). The use of units of measure of "EACH" is optional.

Additional units specific to EEWS are:

PERC = Percent
FLAG = Flag

ABBREVIATIONS AND TERMS

AR - Army Regulation.

ARA - Assigned Responsible Agency.

Category - An equation input necessary to make some researcher-defined equation run. Categories also name the columns of the INSTL and TYPICAL files and the contents of the UNITYPE file. Examples of categories are "EI" (enlisted persons of grade one), "tracked vehicles," or "soil conditions." Often (as in the first two examples), the category will directly relate to the categories in the TO&E lists, but this is not necessary, as in EX(isting). Some are special: RES(ult)s of equations are stored at the location which names the row and the results column (DESCRIPTOR#N,RES) in the INSTL file for the installation under consideration.

CONUS - Continental United States.

DA - Department of the Army.

DOD - Department of Defense (office that oversees all military activities).

DESCRIPTOR - Output a user will see when a report is requested during an EEWS session. Also, a descriptor names a row in the INSTL and TYPICAL files and maybe the name of an equation that generates a result to be displayed. Thus, "descriptor," "equation," "user output," and "INSTL file row name" are all closely related concepts.

EA - Environmental Assessment.

EEWS - Environmental Early Warning Systems.

EIS - Environmental Impact Statement.

Equation - Algebraic or logical statement that tells EEWS from where to get data and how to manipulate it to get a result which can be displayed. Each equation has a name which is also the DESCRIPTOR (the name of a row in the INSTL type of files--see DESCRIPTOR).

EX(isting) - Amount of an item currently existing at an installation. "Existing" and "capacity" often are equivalent concepts. EX also names a column in the INSTL type files. Thus, every descriptor has available the location (INSTL,DESCRIPTOR,EX) for storage of the capacity or existing amount of that descriptor at an installation.

FORSCOM - U.S. Army Forces Command (the "standing Army").

Host Computer - In a conversation between computers, the computer "in charge" is called the "host computer." This is usually the larger, "smarter" computer where information is to be placed initially.

HQ - Headquarters.

INSTL - Type of file that contains installation-specific data. An INSTL type file exists for each installation in EEWS. All INSTL type files are two-dimensional arrays with the equation-name/descriptor as the rows and the inputs to equations/categories as the column names.

LIN - Line item number: the number in the TO&E associated with a piece of equipment the Army unit in question is authorized to have.

MACOM - Major Army Command: the group to which an installation belongs. TRADOC and FORSCOM are MACOMs. A MACOM's HQ coordinates, oversees and determines priorities among the different installations for which it is responsible. It also coordinates with other MACOMs and with DA.

Microcomputer - Small, yet powerful, computer designed to support a single user and a limited amount of data. Data storage medium usually is floppy disks.

NEPA - National Environmental Policy Act.

OCE - Office of the Chief of Engineers.

Operation - Part of an equation that tells EEWS which manipulations are to be performed on the terms. Operations include +, -, *, **, /, (,), GT, LT, GE, LE, NE, for example.

osiris - Name of the Pyramid 90X computer at the University of Illinois Computing Services Department, Urbana, IL.

Pyramid 90X - Computer where EEWS currently resides, commonly referred to as osiris.

RES(ult) - Value calculated by an EEWS equation. RES is the name of a column in the INSTL type file. The result of an equation is stored at the location (INSTL, DESCRIPTOR#N, RES, TOPIC). That value can be used as a term in any equation calculated afterward in the equation list.

Signon - Process of connecting a terminal with a computer. This usually entails turning on the terminal, setting it up, and accessing a computer (either by a direct connection or by phone lines). "Signon" also is used to refer to the password sequence used to gain access to a computer.

Software - Instructions that tell the computer (hardware) what to do.

SRC Number - Standard Requirements Code, or "real" number of a unit which is related to the TO&E (the TO&E is always a hypothetical number). For example, the SCR 57000H420 is associated with a particular type of Airborne Division, an Army unit.

System Maintainer - Person(s) responsible for maintaining a computer, computer system, and/or program.

Tables of Organization and Equipment (TO&E) - Source document that defines the composition of most of the UNITYTYPE file. TO&Es are theoretical descriptions of the normal Army unit's composition. These units are not assigned to a particular location and are not classified.

Term - Part of an equation that refers to a constant or to the location of a piece of data in a file (INSTL, TYPICAL, or UNITYTYPE) to be used in calculating the result for display. All terms, except UNITYTYPE, and CONSTANT, consist of four parts: the file, the row, the column location, and the topic (e.g., INSTL,WATERUSE,CAPACITY UTILITIES).

TO&E - See Tables of Organization and Equipment.

Topic - EEWS area of general concern that consists of many detailed descriptors (i.e., bachelor housing or red-tailed warblers). Topics are broad headings like "Housing" or "Rare and Endangered Species." Contents of a topic are defined by the researcher in charge of that area of interest. Usually, a user will see output by requesting to see the contents of a specific topic or by requesting an aggregated report that displays a single line for each topic to show whether a problem exists anywhere.

TRADOC - U.S. Army Training and Doctrine Command. Responsible for training--either boot camp or ongoing in-service technical training.

TYPICAL file - File that looks exactly like an INSTL file but which contains either an average of the values stored in the same location within all INSTL type files or a hard-wired, researcher-determined default value. This value is used when an installation has no data stored in the same place in its particular INSTL type file.

Unit, Army - Name of a group of demand items or demand item generators that can be moved from one location to another. Army units are normally from the TO&Es (e.g., an infantry battalion; see UNITYTYPE and TO&E). They are normally composed of individuals and equipment. An Army unit can also be a single individual (e.g., an enlisted person of grade 5), a single piece of equipment (e.g., a howitzer), or a training group.

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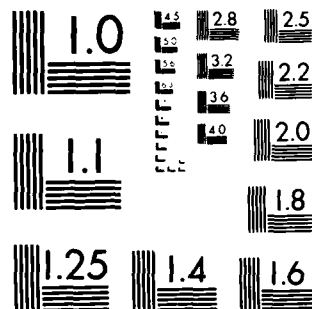
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Unit of Measure - Way in which an item is "sized," e.g., tons, gallons per day, housing units.

UNITYPE file - File containing the list of Army units that can be moved from one location to another and the components of those units. Values in the UNITYPE file are derived mostly from the TO&E. The file consists of the arbitrarily assigned EEWS unit number (which always begins with a U), the TO&E (or SRC) number, and a word description of the unit's name and components. Components can be individuals of different grades, types of equipment, references to subunits of which this unit is composed (e.g., a division may be made up of five battalions), or other items an equation developer may require. There is a relationship between UNITYPE files and INSTL files in that the components/categories of the UNITYPE file are exactly equal to the names of the columns/categories/equation-user inputs of the INSTL file.

UNIX - Operating system developed by The University of California, Berkeley, and trademarked by Bell Laboratories. This is the assumed operating system for EEWS.

USA-CERL - U.S. Army Construction Engineering Research Laboratory.

VAX 11/780 - Minicomputer manufactured by Digital Equipment Laboratories. Supports UNIX, and was used for USA-CERL's initial developmental stages of EEWS.

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